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Brief Observations on Common Mortars, Hydraulic Mortars, and Concretes; with some Experiments made therewith, at Fort Adams, Newport Harbour, R. I., from 1825 *to* 1838; *by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

SECTION V.

ARTICLE XXIII.—*On Lime, Hydraulic Cement, Sand, Mortar making, Strength of Mortars and Grout.*

(CONTINUED FROM VOL. XXI., PAGE 383.)

During the progress of operations under my direction in the construction of Fort Adams, in Newport Harbour, Rhode Island, many experiments were made with mortars exposed in the air; giving, in some cases, results quite interesting. The results are too limited in number and restricted in variety, to justify the deduction of general principles; still they afford some hints that may be deemed worthy of being followed up.

The following tables contain these results in a very condensed form; but before giving the tables, it is proper to make some observations on the materials employed—the manner of using them, and the modes adopted of trying the relative strengths of the essays.

Lime.—Three kinds of lime were used, namely:

1st. "*Smithfield Lime.*"—From Smithfield, R. I. about fifteen miles from Providence. This is a very fat lime—slaking with great violence, when properly burned, and affording a large bulk of slaked lime.

2d. "*Thomastown Lime.*"—From Thomastown (Maine.) This is also a fat lime, at least so far as it has been tried at Fort Adams: but it is probable that some of the many varieties—including those of the neighbouring towns of Lincolnville, and Camden, may prove to be hydraulic. The richer varieties slake promptly, giving a large bulk of slaked lime.

3d. *Fort Adams Lime.* This is made from a ledge of whitish transition limestone found within the domain of the Fort. The stone is very fine grained and compact, exceedingly difficult to break, and crossed in all directions by three veins of whitish quartz. The ledge is a bed, or large nodule, in graywacke-slate. After calcination it yields, by sluggish slaking, a lime decidedly hydraulic. A little of this lime, after being slaked, was made into a cake of stiff hydrate; the excess of water being absorbed by bibulous paper: the cake was placed in the bottom of a tumbler and covered immediately with water. In about $7\frac{1}{2}$ days, a wire $\frac{1}{23}$ of an inch in diameter, loaded to weigh 1 lb., made no impression on this hydrate.

Three modes of slaking the lime were tried in these experiments, namely:

1st. *Slaking by Sprinkling.*—In this mode, water, in quantity sufficient to slake the lime to dry powder, but not enough to afford moist powder, was sprinkled upon the lime. The lime was not made into mortar until it had become cold.

2nd. *Slaking by Drowning.*—In this mode, water enough was given, in the first place, to reduce the lime to a cream of such consistency as to afford mortar of proper "*temper*" for common use without any further addition of water, provided the mortar was made up immediately. If the making the mortar was delayed, a further supply of water became necessary.

3d. *Air-slaking.*—In this mode, lime, reduced to pieces about the size of a walnut, was left in the air to slake spontaneously.

These were the processes by which the lime used in the experiments was slaked: but by neither of these, nor by any modification recommended by others, or that we, ourselves, could devise, were we able to free the hydrate from an infinity of small particles of lime, that being imperfectly, or not at all, slaked in the first instance, it was almost impossible, by any amount of labour afterward, to break down and mix with the rest. The mortar mill, hereafter described, reduced these refractory particles better than any of the ordinary modes of acting upon lime; but not sufficiently, without an unwarrantable amount of labour. All other means having failed, resort was had, at last, for the mortar for the masonry of the Fort, to grinding the dry lime to a very fine powder between millstones. Lime thus ground gives a perfectly homogeneous mortar: and some partial experiments lead to the opinion that the gain in the quantity of lime available for mixtures with sand, will, nearly if not quite, compensate for the expense of grinding. So far as the mortar thus made has been tried, the results were favourable: but the experiments on the quantity and quality of lime thus treated, though they justify confidence, are not, yet, so conclusive as to warrant any positive assertions.

Hydraulic Cement.—Three kinds of hydraulic cement were employed—namely, a kind that will be here designated as *hydraulic cement A*, which was supplied from the State of New York—another kind, called *hydraulic cement B*, supplied from a different manufactory in the same State—and "*Roman (or Parker's) cement,*" imported from England.

The experiments will show a material difference in the respective qualities of these hydraulic cements. According to them, cement A was the best, cement B the next best, and the "Roman cement" the worst; but it must be remarked that the last mentioned had, no doubt, greatly deteriorated, from imbibing moisture during a long voyage, and long keeping in store; while there is reason to suppose that the two first mentioned had been calcined within a few weeks. Between these two, there was also a marked difference; but though the superiority of cement A was probably in part

intrinsic, it was, no doubt, in part, to be ascribed to its greater freshness. These cements, therefore, should, in our tables, be compared with themselves under various combinations with other ingredients, rather than with each other.

This is perhaps the best place to mention a very certain and satisfactory mode of testing the hydraulic quality of lime or cement. It is derived from Raucourt's work on mortars.

Of the lime or cement to be tried, a cake of quite stiff hydrate must be made of a size to lie, without touching the sides, in the bottom of a tumbler: any excess of water should be absorbed from the cake by bibulous paper, until it will just support a wire $\frac{1}{12}$ of an inch in diameter loaded to weigh $\frac{1}{4}$ of a pound—this wire should barely make its impression. Noting the hour and minute of the watch, the cake, thus prepared, should be placed in the tumbler, and covered immediately with water. If the specimen be very hydraulic, it will set almost instantly; if not very hydraulic, it may require days, and if but slightly hydraulic, it may require weeks to harden. In order to have some invariable measure of what we call *setting*, we have always used a wire $\frac{1}{24}$ of an inch in diameter, loaded to weigh 1 pound.

With these two simple instruments, and these simple appliances, the comparative hydraulic qualities of limes and cements may be detected infallibly. It may not be strictly accurate to say that those cements which indurate most promptly under water will afford the strongest mortars in the air; although that has, for the greater part, appeared to be the case, in our experiments; still it is highly probable that such cements will be found among the best; it is, at any rate, amongst such that we should look when in search of mortars of superior excellence; and it is undoubtedly true, that when hydraulic qualities exist in lime, although in feeble proportion, the lime is essentially benefited. A simple means of testing hydraulic quality is therefore of value.

Our experience has, however, taught us one important caution in the use of this test; which is, to leave the cement in the water for a day or two, although it may have set in a few minutes. A cement was under trial which, at the expiration of 7 minutes had set so as to bear the small wire with the weight of 1 pound—and at the expiration of 15 minutes, with the weight of 2 pounds. In about two hours, however, it was entirely soft again, having been broken down by the slaking of some free lime that happened to be present, and which had not had time to slake before the hydraulic ingredients had indurated. After about fifteen hours it was taken out of the water, restored to the condition of stiff mortar, and again immersed. It now hardened very slowly, and was six days acquiring the test hardness. Such cements require peculiar treatment. It is evident that there is great hydraulic energy wasted in the first instance of immersion; because the subsequent swelling of the lime, breaks down the indurated mass; and, removing the hydraulic particles beyond the sphere of mutual action, prevents any useful effect from the remaining hydraulic power. The slaking the lime should, therefore, be complete before the cement is immersed. The best mode of slaking this lime has not been ascertained. Perhaps it would be best to sprinkle a little water on cement of this kind, leaving it for a few hours in the state of moist powder—perhaps leaving it exposed to spontaneous slaking for the requisite time—and perhaps throwing on a small quantity of water, in order to slake the lime, and then exposing the cement to heat for a short time, so as to drive off the water absorbed by the hydraulic constituents. This last mode is suggested by the following facts.

Some hydraulic cement A, which had been in a cask more than one year, on first opening the cask, hardened under water in three hours. After two or three days, it required five hours to harden; and after ten days, about nine hours—the cask being kept covered by the head lying loosely upon it. A little of this cement that had been out of the cask for more than a week, on being heated (but not to a red heat) for a few minutes, set under water in three hours. Some of the same cement that had been in the office, enclosed in paper, for about three weeks, required six hours to harden in water, while a little of it, after being kept on a red hot iron plate for about fifteen minutes, hardened in water in 45 minutes.

This power of restoring the energy of deteriorated cements may have many important applications.

Sand.

Several kinds of sand were used in the experiments, namely:

Sand No. 1.—This is the kind habitually used at Fort Adams in stone masonry. It is entirely free from dirt, and the particles, though not very sharp, are angular. Separated mechanically, it was found to consist, in 100 parts, in bulk, of

particles from	$\frac{1}{6}$	to $\frac{1}{12}$	of an inch in diameter—about		10.00
do.	$\frac{1}{12}$	to $\frac{1}{24}$	do. do.	do.	5.00
do.	$\frac{1}{24}$	to $\frac{1}{48}$	do. do.	do.	48.00
do.	$\frac{1}{48}$	to dust		do.	45.00
do.	dust mostly silicious—no dirt			do.	4.50
100 parts in bulk producing				do.	112.50

Sand No. 2.—Is the above sand freed from particles larger than $\frac{1}{12}$ of an inch.

Sand No. 3.—Is the above sand freed from particles larger than $\frac{1}{48}$ of an inch.

Sand No. 4.—Is sand No. 2, pounded very fine after being freed from dust by washing.

Mortar Making.

With a view to a thorough incorporation of the constituents, at a small expense, and in order, at the same time, to break down the refractory particles of lime before mentioned, a mortar mill was constructed at the commencement of the works at Fort Adams in 1825, which has been in operation ever since.

The mill consists of a very heavy wheel about eight feet in diameter (having a tire one foot broad) moving in a circular trough fifteen inches wide at the bottom—the diameter of the circle being about twenty-one feet. The lime is slaked under the wheel, and ground until, with suitable additions of water, it has become a homogeneous paste sufficiently dilute to make mortar of the ordinary consistency. The requisite quantity of sand is then gradually sprinkled in, as the wheel is in motion. The draught is easy to the horse until near the last; when, for a few minutes, as he is giving the last turns, after all the sand has been thrown in, it is rather heavy.

It was found convenient to use three barrels of lime to each batch of mortar.

The three mortar mills of Fort Adams were competent to supply in one

day 3077 cubic feet of mortar, at a total expense of $0.087 per cubic foot, viz.

105 casks of lime, at $1.52 per cask,	$159.60
2094 bushels of sand, at $0.04 per bushel,	83.76
Carting sand to mill, $0.12 for 20 bushels,	12.56
3 horses and 3 drivers, at $1.50 per day,	4.50
6 labourers, at $1.00 per day,	6.00
1 cooper at $1.00 per day,	1.00
Other small expenses say	0 58
Total cost of 3077 cubic feet of mortar	$268.00

or $0.087 per cubic foot. It appears that the expense of *making* the mortar was $12.08, being about $\frac{1}{3}$ of a cent for a cubic foot.

The proportions in the above mortar are about 1 of lime in paste to $2\frac{1}{2}$ of sand—should the proportion of lime be greater, the mortar will, of course, cost more.

The above statement refers to mortar made without addition of any hydraulic substance. But such mortars are now never used at Fort Adams. Hydraulic cement, or burnt clay, or brick dust, or some other similar matter is added to every kind of mortar made at the work, in proportions varying with the purpose to which the mortar is to be applied. The poorest mortar we make contains 1 barrel of hydraulic cement to 3 barrels of unslaked lime and about 15 barrels of sand; the cement being added before the sand, and while the lime is being reduced under the wheel.

All the mortars used in the experiments in the tables, were made by hand with the trowel, with such exceptions, only, as are noticed.

Trials of the Strength of Mortars.

The strength of mortars as regards tenacity, was determined by measuring the force required to separate bricks that, having been joined by the mortar, had been left, for the desired length of time, in some place safe from frost or accident.

The bricks were joined in pairs, being crossed at right angles thus, so that, supposing each brick to be 4 inches wide, the surface of contact would be 16 square inches. The real surface, or surface of effectual contact, was, in every case, found by actual measurement. The mortar joint separating the bricks was made about $\frac{3}{8}$ of an inch thick: and, in order that this mortar should in all cases be equally consolidated, each pair of bricks was submitted to the pressure of 600 lbs. for 5 minutes, immediately after being joined.

An idea of the mode of separating the bricks may be got from fig. 9, Pl. II, where *a* and *b* represent two strong half-staples fastened to the floor: under these the ends of the lower brick are passed, while the ends of the upper brick are embraced by the piece of iron *c*, *c*, suspended from the steelyard *d*. The force needed to separate the bricks, is applied by pouring sand, at a uniform rate, into the bucket *e*. The weight of the sand and bucket, the mark on the beam where the weight was applied, and the weight of the *poise*, enable us to ascertain the force necessary to tear the bricks asunder. In the tables, the force required to separate the bricks is reduced to the proportional force required to tear up a surface of one square inch: so that if there were 16 square inches of actual contact, and the force used in separating the bricks was 1000 pounds, the table would represent the tenacity of the mortar by $62\frac{1}{2}$ lbs.—equal to $\frac{1000}{16}$.

The hardness of the mortars was determined by ascertaining the weight, applied on a circular plane surface of 0.16 of an inch in diameter, (or .02008 of an inch area,) which the mortar would support. This mode of trial is represented in fig. 10, Pl. II. The circular surface at the extremity *a*, presses upon mortar still adhering to one of the bricks. The arms of the lever *b*, are of equal length, so that the upward force at *c* is equal to the pressure at *a*. The force is applied by means of a steelyard and sand, as in the preceding case.

The experiments were generally made with several pairs of bricks, and a mean was taken of the results; unless it had obviously been subjected to some accident or disturbance, being made to contribute to the mean. Very few results were rejected. There could be only as many trials of *tenacity*, in each particular experiment, as there were pairs of bricks. But for *hardness*, it was often possible to make a considerable number of distinct trials on the same surface of mortar: on the other hand, it would sometimes happen that the surface would be left too ragged and uneven for this trial: and in several instances this test seemed to be entirely inapplicable—the mortar beginning to yield with light weights, and continuing to yield more and more as the weight was increased, the whole effect being a gradual crumbling. In a great majority of cases, however, the effects were sufficiently decided to leave no doubt as to the moment when the power prevailed over the resistance—and sufficiently consistent to afford useful comparisons.

The method, just described, of trying the strength of mortars, was adopted in the Fort Adams experiments, on account of the facility of application. There was, in the first instance, no purpose of extending the experiments beyond what was deemed indispensable to a proper choice, and judicious application of materials, in the construction of a work of some magnitude, then being begun. One series of experiments, however, involved another and another, until the series became extended and the experiments too numerous and valuable, not to make it desirable that subsequent ones should be comparable with them, and, consequently, the same mode of test was continued.

It is probable that the method followed by Genl. Treussart, of making rectangular prisms of mortar, and subjecting them to fracture by weights suspended from the middle, is the best mode. It, at any rate, has the advantage of allowing mortars made in different places, and at distant times to be compared. This mode was adopted in some of the later trials at Fort Adams.

The following table exhibits the mean results of all the experiments made from 1825 to 1832; comprising seven series. The time of exposure of the 1st series was 5 months; of the 2nd. series, 10 months; of the 3rd, 10 months; of the 4th, 5 months; of the 5th, 10 months; of the 6th, 25 months; and of the 7th, 11 months. In the 1st series, there were 2 pairs of bricks to each experiment; in the 2nd, 3 pairs; in the 3rd, 3 pairs; in the 4th, 1 pair; in the 5th, 4 pairs; in the 6th, 2 pairs; and in 7th, 3 pairs.

The first column prefixes a number to each kind of mortar, for convenient reference; the 2nd column expresses the nature, or composition of the mortar; the 3rd column, whether the bricks were *wet* or *dry* when joined together; the 4th, the number of series of which the results are a mean as to *tenacity*; the 5th, the *tenacity*, as expressed by the number of pounds required to tear open a joint of one inch square; the 6th, the number of series of which the results are a mean as to *hardness;* and the 7th, the number of pounds required to force into the mortar a circular plane surface of 0.16 of an inch in diameter.

Table No. LXV.

No.	Nature and Composition of the mortar.	Bricks wet or dry.	Tenacity.		Hardness.		Remarks.
			Number of series affording the mean.	Mean tenacity.	Number of series affording the mean.	Mean hardness.	
1	New York Hydraulic cement B, alone	W	1	32.6			
2	do. do. do. A, alone	W	5	56.2	4	1053	
3	Roman cement (Parker's English) alone	W	1	18.5	1	260	
4	do. (do.) alone	D	1	22.6	1	412	
5	Lime alone	W	1	10.5	1	98	
6	Hydraulic cement A in powder 1 Sand No 3 .50	W	1	61.9	1	1055	
7	Cement A do. 1 Sand the same 1	W	6	40.3	5	993	
8	Cement A do. 1 Sand the same 1.50	W	5	33.1	4	918	
9	Cement A do. 1 Sand the same 1.50	D	2	30.4	1	765	
10	Hydraulic cement A in powder 1 Sand No. 3 2	W	3	17.5	3	670	
11	Cement A do 1 Sand the same 3	W	3	19.8	2	367	
12	Cement A do. 1 Lime slaked to powder .50 Sand the same 1.50	W	2	29.6	3	573	
13	Cement A do. 1 Lime the same .50 Sand No. 2 2	W	4	20.1	3	509	
14	Cement A do. 1 Lime the same 1 Sand No. 2. 2	W	4	28.3	3	778	
15	Cement A do. 1 Lime the same 2 Sand No. 2 4	W	4	17.1	3	545	
16	Cement A do. 1 Lime the same 2 Sand No. 2 6	W	4	16.2	3	267	
17	Cement A do. 1 Lime in paste, .50 Sand No. 2 1.50	W	1	44.4	1	765	
18	Cement A 1 Lime in paste .50 Sand No. 2 1.50	D	1	54.7	1	915	
19	Cement B do. 1 Sand No. 3 1	W	2	18.9			
20	Cement B do. 1 Sand No.2 1.50	W	1	23.4			
21	Cement B do. 1 Sand No. 2. 2	W	2	14.7			

Table No. LXV—Continued.

No.	Nature and Composition of the mortar.	Bricks wet or dry.	Tenacity.		Hardness.		Remarks.
			Number of series affording the mean.	Mean tenacity.	Number of series affording the mean	Mean hardness.	
22	Cement B do. 1 Lime in powder slaked .50 Sand No. 2 2	W	2	17.5			
23	Cement B do. 1 Lime the same 1 Sand No. 2 2	W	2	19.1			
24	Hydraulic cement B in powder 1 Lime slaked in powder 2 Sand No. 2 4	W	2	18.1			
25	Cement B 1 Lime the same 2 Sand No. 2 6	W	2	15.0			
26	Roman cement 1 Sand No. 2 .50	W	1	19.2	1	397	
27	Roman cement 1 Sand No. 2 1	W	1	16.8	1	309	
28	Roman cement 1 Sand No. 2 1.50	W	1	13.3	1	286	
29	Roman cement 1 Lime in paste 0.50 Sand No. 2 1.50	W	1	26.7	1	471	
30	Roman cement 1 Lime in paste 0.50 Sand No. 2 1.50	D	1	29.1	1	787	
31	Lime in powder 1 Sand No. 3 3.50	W	3	12.3	1	159	
32	Lime in powder 1 Sand No. 3 6	W	1	5.6	1	107	
33	Lime in paste 1 Sand No. 3 .50	W	1	14.3	1	208	
34	Lime in paste 1 Sand No. 3 1.50	W	3	15.4	2	275	
35	Lime in paste 1 Sand No. 3 3	W	4	12.8	2	146	Made with a hoe.
36	Lime in paste 1 Sand No. 3 2.50 *a* 3	W	6	14.3	3	202	Made in mortar mill.
37	Lime in paste 1 Sand No. 3 2.50 *a* 3	D	5	14.9	4	254	do. do.
38	Lime in paste 1 Sand No. 1 2.50 *a* 3	W	1	13.7	1	217	do. do.
39	Lime in paste 1 Sand No. 1 2.50 *a* 3	D	1	16.2	1	200	do. do.
40	Lime in paste 1 Sand No. 1 2	W	1	35.8	1	242	Lime different.
41	Lime in paste 1 Sand No. 1 2	D	1	26.6	1	231	

Observations on the Experiments of Table No. LXV.

1st. Generally, within the limits of the experiments, *a mortar made of lime and sand, or of hydraulic cement and sand, or of hydraulic cement, lime and sand—whether it was cement A, or cement B, or Roman cement, was the stronger, as the quantity of sand was the less.* In 24 comparisons, 3 exceptions.

In 13 comparisons of *tenacity*, 2 exceptions.

In 11 comparisons of *hardness*, 1 exception.

2nd. *It appears that with cement A, or cement B, any addition of sand weakens the mortar.* In all the cement experiments, except one, composed of Roman cement 1—sand $\frac{1}{2}$ (No. 26,) the cement alone, was stronger than when mixed with sand in any proportion whatever. Cement A (No. 6,) would seem to be another exception, but it is not; the strength of cement A, alone, as given in No. 2, is the average of five results with different specimens of cement, some of which were of inferior quality; while the result given in No. 6 is of one trial only, and that of a cement proving to be the best used; the particular result of No. 2 which corresponds with No. 6—that is to say, which was afforded by the same specimen of cement, gave for *tenacity* 74.7 lbs. and for *hardness* 1063 lbs., while No. 6 shows a *tenacity* of 61.9 lbs. and a hardness of 1055 lbs.

3rd. *It appears that when cement mortars are not required to be the strongest that can be made—a little lime may be added, without great loss of tenacity, and, of course, with a saving of expense.*

4th. *Mortar made in the mortar-mill was superior to mortar made by being mixed, in the common mode, with the hoe.*

5th. *When the bricks were dry and the mortar more fluid than usual, the mortar was better, both as to* TENACITY *and* HARDNESS—*in five cases out of seven, than when the bricks, being wet, were put together with mortar of common consistence.*

In the next table there is a comparison of the three kinds of lime—of the three modes of slaking, of various proportions of sand—of the effect of wet and of dry bricks on the mortar, &c.

In most cases six pairs of bricks were put together at the same time, and of the same materials; of which three pairs were separated after about 6 months, and the remainder after the lapse of 4 years and 5 months.

Table No. LXVI.

Showing the tenacity and hardness of mortars variously composed after exposure in the air.

No.	Nature and composition of the mortar.	Bricks wet.				Bricks dry.				Remarks.
		Tenacity per square inch.		Hardness.		Tenacity. per square inch.		Hardness.		
		After 6 months.	After 4 years and 5 months.	After 6 months.	After 4 years and 5 months.	After 6 months.	After 4 years and 5 months.	After 6 months	After 4 years and 5 months.	
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
1	*Paste of Smithfield lime slaked by* DROWNING 1 / Sand No. 2 1	20.4	42.8	119	220					There are two kinds of Fort Adams lime in the table. The first, A, was imperfectly calcined: the second B, was thoroughly burned.
2	Lime the same 1 / Sand No. 2 2	15.2	18.8	130	297					
3	Lime the same 1 / Sand No. 2 3	12.6	16.6	182	232					
4	Lime the same 1 / Sand No. 2 4	13.2	16.4	85	203					
5	*Paste of Thomastown lime slaked by* DROWNING 1 / Sand No. 2 1	11.3	38.3	216	300		40.3		355	
6	Lime the same 1 / Sand No. 2 2	17.1	38.3	123	273		39.1		310	
7	*Paste of Thomastown lime, slaked by* DROWNING 1 / Sand No. 2 3	24.7	27.6	265	240		38.0		220	
8	Lime the same 1 / Sand No. 2 4	15.1	21.7	214	210		35.4		203	
9	*Paste of Fort Adams lime A slaked by* DROWNING 1 / Sand No. 2 1	13.4	21.9	105	273		34.0		186	
10	Lime the same 1 / Sand No. 2 2	9.9	18.8	68	175		22.5		110	
11	Lime the same 1 / Sand No. 2 3	12.6	22.7	75	93		22.8		187	
12	Lime the same 1 / Sand No. 2 4	9.6	11.5	92	93		21.4		102	
13	*Paste of Thomastown lime, slaked by* SPRINKLING 1 / Sand No. 2 1	26.8	49.1	259	798		40.6		787	
14	Lime the same 1 / Sand No. 2 2	26.4	35.6	225	666		57.3		370?	
15	Lime the same 1 / Sand No. 2 3	26.3	37.0	285	392		26.2		625	
16	Lime the same 1 / Sand No 2 4	25.2	31.0	289	313		38.0		347	
17	*Paste of Fort Adams lime B slaked by* SPRINKLING 1 / Sand No. 2 1	32.9	47.8	446	900		56.7		620	

Table No. LXVI. Continued.

No.	Nature and Composition of the mortar.	Bricks wet. Tenacity per square inch. After 6 months.	Bricks wet. Tenacity per square inch. After 4 years and 5 months.	Bricks wet. Hardness. After 6 months.	Bricks wet. Hardness. After 4 years and 5 months.	Bricks dry. Tenacity per square inch. After 6 months.	Bricks dry. Tenacity per square inch. After 4 years and 5 months.	Bricks dry. Hardness. After 6 months.	Bricks dry. Hardness. After 5 years and 5 months.	Remarks.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
18	Lime the same 1 Sand No. 2 2	33.1	54.5	228	600		52.4		507	
19	Lime the same 1 Sand No. 2 3	28.9	43.1	221	327		51.8		266	
20	Lime the same 1 Sand No. 2 4	23.5	30.4	254	258		52.6		233	
21	*Paste of Smithfield lime* AIR SLAKED 1 Sand No. 2 1		22.4		126					
22	Lime the same 1 Sand No. 2 2		9.9		85					
23	*Paste of Thomastown lime* AIR SLAKED 1 Sand No. 2 1				37?					
24	Lime the same 1 Sand No. 2 2		6.0		20?					
25	*Paste of Fort Adams lime* B AIR SLAKED 1 Sand No. 2 1		29.2		664					
26	Lime the same 1 Sand No. 2 2		21.6		281					
27	*Paste of Fort Adams lime* B *slaked by* DROWNING 1 Brick dust 0.40 Sand No. 2 1.40	16.3		104						
28	Lime the same 1 Dust of burnt clay .50 Sand No. 2 .50	17.5		168						
29	*Paste of Thomastown lime slaked by* SPRINKLING 1 Brick dust 2	35.0		360						
30	*Paste of Thomastown lime slaked by* DROWNING, measured before slaking 1 Sand No. 2 5	12.2	18.5	102	263		22.5		192	
31	Lime the same* 1 Cement A .33 Sand No. 2 5.50	15.4	23.1	165	192		42.6		230	
32	*Paste of Fort Adams lime* B *slaked by* DROWNING, measured before slaking 1 Sand No. 2 5	25.7	48.8	130	650		17.8		652	
33	Lime the same* 1 Cement A .33 Sand No. 2 5.50	22.7	46.7	194	849		46.2		303	
34	Cement A in powder 1 Sand No. 2 1.50	63.3	72.4		1508	467	88.4		1659	

*Equal, lime 1 Sand 5.00 / Cement 0.33 do. 50 / Lime 1 Cement 0.33 Sand 5.50

Observations on the experiments of Table No. LXVI.

1st. *Within the limits of the experiments, whatever was the mode of slaking, or the kind of lime, the mortar was the stronger as the quantity of sand was less.*

The lime being measured in paste, the proportions were 1 of lime to 1 of sand; 1 of lime to 2 of sand; 1 to 3, and 1 to 4 of sand.

In all the corresponding trials of the table,

1 lime in paste, to 1 sand, gave the strongest mortar in 35 cases of tenacity, and in 13 cases of hardness.

1 lime in paste, to 2 sand, gave the strongest mortar in 3 cases of tenacity, and in 1 case of hardness.

1 lime in paste, to 3 sand, gave the strongest mortar in 2 cases of tenacity, and in 2 cases of hardness.

1 lime in paste, to 4 sand, gave the strongest mortar in 0 cases of tenacity, and in 1 case of hardness.

2d. *Slaking by* DROWNING, *or using a large quantity of water in the process of slaking, affords weaker mortar than slaking by* SPRINKLING.

In 24 corresponding cases of the table—The quantity and quality of the materials being alike: and there being no other difference than in the modes of slaking the lime.*

Lime slaked by SPRINKLING, gave the best mortar in 22 cases of tenacity, and in 24 cases of hardness.

Lime slaked by DROWNING, gave the best mortar in 2 cases of tenacity, and in 0 case of hardness.

The average strength in all the 24 cases in which the lime was slaked by *drowning* was, as to tenacity, 23.79 lbs., and as to hardness, 187.00 lbs.

While the average strength in all the 24 cases in which the lime was slaked by *sprinkling* was, as to tenacity, 38.63 lbs., and as to hardness 417.33 lbs.

The relative tenacity then is as 1 to 1.62; and the relative hardness as 1 to 2.23.

3d. *The experiments with air* SLAKED LIME, *were too few to be decisive—but the results were unfavourable to that mode of slaking.*

Average strength of the mortar made of *air-slaked* lime as to tenacity 20.80 lbs., and as to hardness 202.18 lbs.

Average strength of the corresponding mortars made of lime slaked by *drowning*, as to tenacity 27.10 lbs., and as to hardness 207.50 lbs.

Average strength of the corresponding mortars made of lime slaked by *sprinkling*, as to tenacity 46.70 lbs., and as to hardness 533.83 lbs.

4th. *The mortars were very materially stronger at the end of* 4 *years and* 5 *months, than at the end of the first half year.*

Of the 26 mortars which enter into this comparison, the average strength at the end of 6 months was, as to tenacity, 22.54 lbs., and as to hardness 166.33 lbs., and at the end of 4 years and 5 months it was, as to tenacity, 35.45 lbs., and as to hardness 367.37 lbs.

The relative tenacities being as 1 to 1.57, and hardness as 1 to 1.97 lbs.

5th. *Brick dust, or the dust of burnt clay, improves the quality of mortars both as to tenacity and hardness.*

6th. *Hydraulic cement added, even in small quantities, to mortars, improves their quality sensibly.*

* Except in their being two different burnings of Fort Adams lime

7th. *The tenacity of mortars seems to have been increased by using dry bricks, and making the mortar a little more fluid than usual. But the hardness of the mortars was rather the greatest when* WET BRICKS *were used.*

In 21 corresponding instances, *wet bricks* and mortar of common consistency gave the best results, as to tenacity, in 5 instances; and, as to hardness, in 12 instances. *Dry brick* and mortar more fluid, gave the best results as to tenacity in 16 instances; and as to hardness, in 9 instances.

Table No. LXVII.

Trials in December, 1836, of mortars made in December, 1835. The results show the weights in pounds required to break prisms of mortar 2 inches square, 6 inches long and 4 inches in the clear between the supports.

No. of the comparison.	Sand No. 2.	Lime ½ slaked to powder with 1-3 of its bulk of water, measured in paste.	Cement A, cask No. 1, measured in paste.	Lime from the same barrel. Mortars made with the least possible quantity of water.	Mortars made rather thin.	Mortars made with equal parts of water and bitter-water.	Mortars made with bitter-water alone.	Mortars made of cement A, cask No. 2, which required much more time to set under water than cask No. 1.	Mortar made of calcined clay instead of cement A, cask No. 1.	Mortar made of sand No. 4, instead of sand No. 2.	Lime slaked with water enough to make a thin paste—and made into mortar after 12 hours. Stone Lime.	Shell Lime	Lime from the same barrel. Lime slaked with ½ its bulk of water, after being kept sealed hermetically in a jar 3 months.	Lime slaked to cream at first, and kept in that state in a keg under ground for 3 months.	Lime allowed to slake spontaneously for 3 months.	Lime slaked to powder with 1-3 its bulk of water and kept dry in a tight keg for 3 months.
1	1		¾	497	370	323										
2	1		⅞	562	502											
3	1		1	655	525	703	206									
4	1		1¼	782	516											
5	1		1½	707	721	1125	483									
6	1		1¾	783	712											
7	1		2	844	694	984	452									
8	1	1	¼		117			103	115	197						
9	1	⅛	⅛		351		220									
10	1	1	⅛		155			164	178	211						
11	1	1	¼		337			173	155	412						
12	1	½	1		469		295									
13	1	1	1		426			178	206	328						
14	1	1	1¼		328			305	187	469						
15	1	1	1½		295		295	267	206	426						
16	1	1	1¾		337			305	206	351						
17	1	1	2					548		511						
18	1	1	3		417		454	455								
19	1	1	4		389		455	520		806						
20	1	1	5		492		548	530		633						
21	1	1	6		576		553	649		862						
22	1	1									206	141	401	286	253	286
23	2	1									155	129	412	225	244	
24	3	1									122	173	356	160	159	244
25	4	1									131	89	286	169	150	220

Observations on Table No. LXVII.

It results from this table, and from the tables from which it has been abridged,

1st. *That in mortars of cement and sand (no lime) the strength is generally greater as the quantity of sand is less.* In 33 comparisons, 12 exceptions.

2nd. *That in mortars of sand, cement and lime—the lime remaining the same in quantity, the mortars were stronger as the quantity of sand was less in proportion to the cement.* In 57 comparisons, 10 exceptions.

3rd. *That in mortars of cement, sand and lime—the quantities of cement and sand being the same—the mortars were stronger as the quantities of lime were less.* In 52 comparisons, 15 exceptions.

4th. *That mortars made of cement and sand were materially stronger when the least possible quantity of water was used, than when the mortars were made thin.* In 14 cases, 1 exception.

5th. *That mortars made of cement and sand with the least possible quantity of water, were stronger when kept in a damp place, than when kept in a dry one.* In 7 comparisons, 1 exception. The experiments did not prove this to be true with reference to mortars made thin. These results were afforded by the experiments but are not included in the above table.

6th. *That in mixtures of lime and sand in various proportions, the mortar was generally stronger as the lime was slaked with less water.*

The average strength of several trials with 0.30 of water being represented by 80—with .40 of water, it was 98—with .60 of water, it was 72—with .80 of water, it was 60, and with 1.00 of water, it was 57. These results were afforded by the experiments, though not included in the table.

7th. *That mortars of lime and sand are materially improved by the addition of calcined clay, but not so much as by the addition of cement A.*

8th. *That sand freed from dust by washing and then pounded fine, gives much better mortars, than a sand composed of particles of every size from dust (no dirt) up to grains $\frac{1}{12}$ of an inch diameter.* In 21 comparisons, 2 exceptions.

9th. Many experiments were made to ascertain whether of two cements of the same manufactory, the difference being, probably, only difference of age, that cement which sets the quickest under water will give the strongest mortars in the air after a considerable lapse of time. The results leave the matter in doubt. The quick cement sometimes giving stronger mortars, and sometimes weaker.

10th. Of lime kept for three months after being slaked, before being made into mortar—the lime slaked into powder by sprinkling one-third of its bulk of water, gave the strongest mortar—represented by 250 lbs.; the lime slaked into cream gave the next strongest mortar—represented by 210 lbs., and the lime slake spontaneously during three months, the weakest mortar, represented by 202 lbs. All these mortars being much inferior to that made of the same lime which had been carefully preserved from slaking by being sealed hermetically in a jar—this last mortar being represented by 364 lbs. It must be remarked here that this result is very extraordinary for fat lime and sand; and it is probable this particular barrel of lime was somewhat hydraulic.

11th. Mortars of cement and sand in which bitter-water alone was mixed (Bitter-water being the mother water after the separation of muriate of soda from sea water,) were weaker than those in which water, or a mixture of equal parts of water and bitter-water, was used. But a mixture of equal parts of water and bitter-water gave much better mortar than water alone—the strongest composition we had, being cement $1\frac{1}{2}$, sand 1, and equal parts of water and bitter-water. In 8 comparisons, 2 exceptions.

The trials that afforded the two exceptions were with mortars containing a smaller proportion of cement than the six others. These facts seem to show that the addition of bitter-water, within certain limits, improves the cement, but that beyond these limits it is injurious; and that where the proportions of cement are great, an increased addition of bitter-water may be advantageous. These particular experiments were made in consequence of finding that the addition of a little bitter-water hastened the setting of cement A when immersed.

12th. *Mortars of cement and sand are injured by any addition of lime whatever, within the range of the experiments; that is to say from sand* 1, *lime* $\frac{1}{8}$, *and cement* $\frac{1}{2}$; *to sand* 1, *lime* 1, *and cement* 2. No exceptions in 67 comparisons.

13th. *Stone-lime, in the proportions tried, gives better mortar than shell-lime, as* 153 *to* 133: but some previous trials had afforded results slightly the best with shell-lime.

Table No. LXVIII.

Trials made in June, 1836, *of mortars made in September*, 1835.

The results show the weights, in pounds, required to separate each inch square of surface of bricks joined by mortars. The object is to compare grout with mortar.

No. 1.	Sand No. 2.	Lime slaked to powder and measured in paste.	Cement A.		Mortar.	Grout.
1	2	1		Lime and cement the same.	30.12	17.19
2	2	1	$\frac{1}{2}$		33.33	17.84
3	2	1	$\frac{1}{4}$		31.35	15.13
4	2	1	$\frac{1}{8}$		32.14	25.14
5	2	1	$\frac{1}{16}$		41.06	21.42
6	2	1	1		39.64	34.68
7	2	1		Lime and cement the same.	22.94	23.08
8	2	1	$\frac{1}{2}$		23.38	14.22
9	2	1	$\frac{1}{4}$		27.07	12.67
10	2	1	$\frac{1}{8}$		29.93	16.96
11	2	1	$\frac{1}{16}$		33.79	22.71
12	2	1	1		36.69	19.75

Observations on Table No. LXVIII.

In order to compare the strength of grout with that of mortar, bricks were joined (as before described) with the mortar given in the table—there being 4 pairs to each kind of mortar. To obtain similar joints of grout, bricks were supported on their ends and edges, in a box large enough to contain all, in such a way as to admit the proper quantity of grout to flow in between each pair. The box was not disturbed until the grout had become quite stiff, when it was first laid on one side, and then taken to pieces. The excess of grout was carefully cleared away from the bricks, which were removed without injury to any of the pairs, and put away by the side of the bricks joined with mortar.

It will be seen that, in every case but one, the grout was much inferior

to the mortar. The average strength of all the mortars in the table is 31.78, and the average strength of all the grouts is 20.06

Changes of bulk on slaking lime—making mortar, grout, &c.

A great many measurements were made of the changes of bulk in the operations of slaking, lime, making mortars &c., and the results, as might be expected, varied with the qualities of the lime. The following condensation of the results may be useful.

						trials.	varying from
1 lime and	½	water made, as a mean,	2.25	of powder.		27	1.56 to 2.97
1 do.		do.	do.	1.74	do.	4	1.55 to 1.83
1 do.		do.	do.	1.81	do.	4	1.63 to 1.95
1 do.	1	do.	do.	2.06	do.	4	1.77 to 2.39
1 do.	2.54	do.	do.	2.68	of thin paste.	3	2.50 to 2.82
			Slaked by drowning.				
1 do.	1.70	do.	do.	1.98	do.	6	1.73 to 2.36
			Slaked by sprinkling.				

Lime in powder.	Water.					
1	0.40	made, as a mean,	0.66	thick paste.	2	0.65 to 0.67
1	0.50	do.	do.	0.76 thinner paste.	19	0.67 to 0.94

1 lime air-slaked gave, as a mean, 1.84 powder 3 1.37 to 2.41

1 of air slaked lime in powder and 0.50 water made, as a mean, 0.75 thin paste, 2 trials varying from .70 to .80.

1 of lime (quick) pounded to powder, made 0.90 of powder, 1 trial.

1 of lime slaked to powder, kept dry for 3 months, still measured 1.00, 1 trial.

Sand.	thin paste.	cement.		mortar.	trials.	varying from.
1	52	00	made, as a mean,	1.17	13	1.06 to 1.21
1	58	0.125	do.	1.25	23	1.70 to 1.50
1	55	0.25	do.	1.37	3	1.29 to 1.54
1	61	0.35	do.	1.43	3	1.38 to 1.57
1	72	0.50	do.	1.60	2	1.50 to 1.70
1	1.00	0.125	do.	1.78	1	
1	1.00	0.25	do.	1.85	1	
1	1.00	0.50	do.	2.18	1	
1	1.10	0.75	do.	2.14	1	
1	1.40	0.25	do.	2.20	1	
1	1.28	1.00	do.	2.36	1	
1	1.00		do.	1·71	1	
1	2.00		do.	2.14	1	

1	50	00	do.	0.32	water,	made	1.27	grout.
1	50	0.062	do.	0.45	do.	do.	1.50	do.
1	50	0.125	do.	46	do.	do.	1.55	do.
1	50	.25	do.	51	do.	do.	1.66	do.
1	50	.375	do.	52	do.	do.	1.78	do.
1	50	.50	do.	61	do.	do.	1.88	do.

202	of mortar	with 87	of water	made	290	of grout.
213	do.	87	do.	do.	305	do.
430	do.	180	do.	do.	604	do.
467	do.	201	do.	do.	660	do.
430	do.	180	do.	do.	620	do.

495 of mortar with 176 of water made 664 of grout.
553 do. 180 do. do. 711 do.

ARTICLE XXIV.—*Observations and experiments on Concrete, &c.*

It was ascertained, by careful measurement, that the void spaces, in 1 bulk of sand No. 1, taken from the middle of the heap, amounted to 0.33: the cementing paste, whatever it may be, should not be less therefore, than one-third the bulk of this sand. Taking one bulk of cement A, measured in powder from the cask, and a little compacted by striking the sides of the vessel, water was added till the consistence was proper for mortar: 0.35 of water was required to do this, and the bulk of the stiff cement paste was 0.625. To obtain, at this rate, an amount of cement paste equal to the voids (0.33) in the sand, will require, therefore, 0.528 cement in powder, and 0.185 of water, or

Dry sand,	1.000	making a bulk of 1.000 of mortar.
Cement in powder,	.528	
Water,	.185	

It is by no means certain that a mortar composed on this principle will be the most tenacious that can be made—on the contrary our experiments indicate that the mortar would be stronger with a smaller proportion of sand; but possessing the minimum quantity of cementing constituent, which is by far the most expensive ingredient, it affords the cheapest admissible mortar, made of cement and sand; and as it was probable, that it would shrink very little on drying, it was tried as a *pointing* for exposed joints, and also as *stucco*, and it answered very well for both purposes—becoming very hard, and never showing the slightest crack. An excess of cement, and a very *slight excess of water*, above the stated proportions, should be allowed for imperfect manipulation, because the proportions suppose every void to be accurately filled.

Extending the application of this principle to concrete—experiment showed that one bulk of stone fragments (nearly uniform in size, and weighing about 4 oz. each) contains 0.482 of void space. To convert this bulk of stones into concrete, we, in strictness, need use no more mortar than will fill this void space; and to compose this mortar we need use no more cement than is necessary to occupy, in the state of paste, the voids in 0.482 of sand. This concrete would therefore be composed as follows:

Stone fragments about 4 oz. each,	1.000	making a bulk of 1.000 of concrete.
Sand No. 1 . .	.482	
Cement in powder, .	.255	
Water, . .	.089	

Obtaining thus a cubic yard of concrete by the use of one-fourth of a cubic yard of cement in powder, (about one and a half bbls.)

But the above fragments were of nearly equal size, and of a form approaching the spherical: affording more void space than if they had been more angular, and had varied in size from about six oz. to less than one oz. such as would commonly be used. We have found that clean gravel, quite uniform in the size of the pebbles, which were about half an inch in average diameter, afforded voids to the amount of 0.39. And Mr. Mary, a French Engineer, used pebbles, probably mixed of coarse and fine, of which the voids were 0.37. The above allowance of 0.482 for void space is therefore quite large.

In all cases of the composition of concrete, the quantities expressed above, should be ascertained by actual measurement of the particular cement, sand and fragments, or pebbles, that are to be used. No better mode of measuring the void spaces, will be found, probably, than measuring the quantity of water that can be poured into a vessel already filled with stone fragments, pebbles, or sand, as the case may be.

Although the hydraulic property of cement will be the cause, in all cases of its use in concrete, it may happen that the cement at hand is more energetic than is actually necessary, and that the concrete would fully accomplish the object in view, even if it should be two or three weeks in becoming hard and impervious to water. Under such circumstances lime may take the place of part of the cement, with great economy. The lime may be added either in the state of powder that has been slaked some time, or in the state of paste: but in either case, the previous slaking must be complete.

The mortar is to be made first, and then the pebbles, or broken stones, may be mixed therewith by turning them over several times with the shovel.

When it is to be deposited under water, it is still a disputed point whether the concrete, prepared as above, should be used immediately, or be left in heaps to stiffen to such a degree as to require the use of pickaxes to break down the heaps: but, in works out of water, there can hardly be a case in which it will not be best to place it at once in its allotted space, where it should be compacted by ramming till none of the stone fragments project above the common surface. One or two trials will show how much mortar over and above the strict proportion is necessary in each case.

In circumstances where ramming cannot be applied, as when depositing concrete in deep water, the concrete should be more yielding and plastic —containing a larger proportion of mortar, and the mortar should be rammed before being deposited, in order thoroughly to imbed the larger constituents.

In many situations where concrete may be resorted to with great advantage, the economy need not stop at the above proportions. This substance may be rammed between, and upon, stones of considerable size—the only indispensable precaution being, to make sure that the stones are perfectly clean, are well imbeded in the concrete, and are far enough apart to permit the full action of the rammer between them.

The following case occurred at Fort Adams in October, 1836.

The proportions adopted were, *fragments of granite*, of		
nearly uniform size, and about 5 oz. each,	1.000	Bulk of
Sand No. 1 . .	0.500	concrete, a
Cement A, in powder, . -	0.280	little more
Water rather more than .	0.100	than 1.000.

Experiment gave 16.683 as the number of cubic feet of concrete made by 1 barrel of cement—187 barrels were consumed which afforded 115.52 cubic yards of concrete. There were also used, 11.29 struck Winchester bushels of sand, and 22.58 struck Winchester bushels of granite fragments.

187 barrels of cement at $2.45	$ 458.15
1129 struck bushels of sand at $0.37	41.77
2258 do. granite fragments at $0.04	90.32
Carried over,	$ 590.24

Brought over,	$ 590.24
There were 151 days labour, applied to making mortar—making concrete—depositing the concrete in its proper place, ramming it into a compact mass, and doing all other work required in the operation.	
151 days at $ 092. .	138.92
Supervision .	10.00
Cost of 115.52 cubic yards,	$ 739.16
Cost of one cubic yard $ 6.40	

Springs of water flowed over this work continually; and were allowed to cover each day's work. The next morning the concrete was always found hard and perfectly set.

Had we dispensed with one half of the cement used, and used in lieu thereof, as much paste of lime, as the cement dispensed with would have furnished of paste of cement, the cost would have been materially reduced, and the work have been still very hydraulic, and very strong. In that case, the bulk would not have been altered, but would have been as before, 115.52 cubic yards. We should have used 93½ bbls. of cement less than we did: and, as cement, in passing to the state of paste, diminishes in bulk in the proportion of 1 to .625, we should have used 93.5×.625 equal to 58.43 barrels of paste of lime. Saving, thereby, the difference between the cost of 93.5 barrels of cement and 58.43 barrels of paste of lime.

93. 5 barrels of cement at $ 2.45	$ 229.07
58.43 do. of paste of lime at $ 0.60	36.06
Amount saved	$193.01

$ 739.16, less $ 193.01, equal $ 546.15; the cost of 115.52 cub. yards.
Cost of one cubic yard $ 4.73.

Another Instance.

Proportions—Clean gravel,	1.000	Bulk of concrete about 1.15
Sand No. 1,	.530	
Cement A, in powder,	.430	
Water about,	.140	

This was rammed into a mould of the capacity of 13.786 cubic feet.

Cement A,	4.35 struck bushels at	$ 0.59		cost $ 2.57
Sand No. 1, washed	5.44 do.	"	0.04	.22
Gravel	10.00 do.	"	0.04	.40
Cost of all the labour,	.	.	.	1.03
Total cost of 13.786 cubic feet,				$ 4.22

Being $ 0.306 per cubic foot, or $ 8.26 per cubic yard.

This became very hard, and is a very good substitute for stone, in certain applications.

Another Instance.

Proportions—Clean gravel,	1.000
Sand No. 1,	.625
Cement A, in powder,	.333
Water, about	.125

This was rammed into a mould of the capacity of 7.812 cubic feet; and the whole cost was $ 2.15, being $ 0.276 per cubic foot, or $ 7.45 per cubic yard.

This became a hard mass, but the concrete was rather too incoherent to make the best factitious stone.

Another case.

In this instance, a box containing 7.812 cubic feet was filled, first, with pieces of a stone of slaty structure—laying the pieces on their beds; a grout was then poured in, until all the interstices were filled. The composition of grout was as follows.

Washed sand No. 1,	1.000
Cement A in powder,	1.000
Water,	.910

The whole cost was $2.40—being $0.31 per cubic foot—or $8.37 per cubic yard.

This mass became hard, but was not so strong as those made of mortar instead of grout.

Numerous objects have, at different times, been moulded at Fort Adams, with analogous compositions, and always with success. Sometimes concrete was used, the entire mass being rammed into the mould: at other times the mortar without the fragments was used *as mortar*; bricks, or fragments of stones, being laid therein, in successive strata, until the mould was filled. Shafts of columns—the Doric echinus, abacus, &c., thus formed many years ago, resist the climate well, although less perfect than we should now be able to produce.

All our experiments concur in showing that much sand weakens cement mortar essentially; at least when exposed to the air. The improvement to be applied to the foregoing proportions should consist therefore, if the expense be no objection, in increasing the quantity of cement—taking care to keep the quantity of water as low as possible, in order to retain the shrinkage of the indurated mass at a minimum. It is surprising how much water may be driven out of an incoherent and apparently half-dry heap of cement-mortar, by hard ramming: and it is still more surprising, after the exact quantity necessary to saturation has been supplied, how small a quantity of water will suffice to convert a dry and powdery heap, if well worked, into a thin paste. Cements vary in their capacity for water: hence the dose of water is a matter that must be established by experiment in each case. The true quantity for concrete, and moulded objects in air, is that which, with hard ramming, affords a stiff paste, with a *little* free water on the surface: a state to which it can be brought with difficulty under the trowel or under the shovel. More water than this is attended with the double disadvantage of lessening the density of the mortar when dry, and of causing cracks by the shrinkage. If the quantity of water be thus regulated, the quantity of cement may be increased at pleasure, but the expense will increase rapidly with every addition of cement. In the first concrete above, the bulk of the dry cement is about one half the bulk of the sand, and the expense per cubic yard is $6.40; make the dry cement to equal the sand in bulk, and the expense per cubic yard will be about $10.00, all other proportions remaining, as they ought, the same.

In the preceding proportions it has been supposed that the concrete was to be used in the air, and that nothing would prevent the free use of the rammer. But if the concrete is to be deposited under water beyond the reach of this instrument, there should be a change of the proportions; and the quantity of mortar should be so increased that the fragments will be certain to be severally imbedded therein from their own weight, the gentle operation of the rake and other leveling instruments, and the pressure of the superincumbent concrete. Attention must be paid to the constituents

of the mortar, in reference to hydraulic energy, also, especially in running water: this mortar must not only be very hard after a time—it must become hard speedily; and to attain this end, the materials at command may demand proportions quite different from those required to fill the voids in the sand.

The following instances are derived from the practice of the French.

M. Mary, Engineer des Ponts et Chausseés, states that he ascertained the voids between the stones to be .37 of the whole bulk—that filling .90 parts of a box with stones, .10 parts+(.37×.90=.33)=.43 parts of mortar would be required, in theory, to fill the box: but he found that the box was more than full, showing that some of the mortar designed to occupy the voids did not reach them, from imperfect manipulation. Instead of .90 parts, he then filled .87 parts of the box with stones, which required that the mortar should amount to .13+ (.37×.87=.32) =.45 parts of mortar; and this he found filled the box very exactly. He also found that the transportation of the concrete, in wheelbarrows, from the mortar bed to the place where it was to be deposited, produced agitation enough to settle all the stones to their places, and bring the excess of mortar to the top. M. Mary is not aware that so large a proportion of stones had been employed any where else than at Pont-de-Remy, at Abbeville, and at the upper dam of Saint Valery; but at these places, no disadvantage resulted from the quantity, and the concrete was impervious to water. The mortar mixed with these stones was composed of 0.22 parts of feebly hydraulic lime measured in paste—0.225 of sand—and 0.225 of brick, or tile, dust ("*cement.*") The proportions of this concrete were therefore, as follows:

	Stones,	.87	Total bulk 1.000
	Sand,	.225	
	Brick, or tile dust,	.225	
	Feebly hydraulic lime in paste	.22	
	Water,		
Or—	Stones,	1.000	1.15
	Sand,	.259	
	Brick or tile dust,	.259	
	Feebly hydraulic lime in paste,	.253	
	Water,		

At the lock of Haningue the cube of concretes was composed as follows:

Pebbles,	.69	Bulk 1.00
Sand,	.40	
Hydraulic lime in paste,	.22	
Water,		

As to this case M. Mary observes that it is probable the pebbles were a mixture of coarse and fine gravel; because, with these quantities, in order to make up the cube of 1.00, the void spaces could amount to only about .09. This would be about 13 per cent. only of the measure of the pebbles, instead of 37, found by M. Mary, himself, in the case stated above. Expressing, as in the other cases, the proportions used at this lock, in parts of the measure of pebbles—it would stand thus,

Pebbles,	1.00	Bulk 1.45
Sand,	.58	
Hydraulic lime in paste,	.32	

To found the pier of the suspension bridge communicating between la Grève and l'ile de la Cité, at Paris, a concrete was used which was much more hydraulic than those just mentioned. It was thus composed:

Fragments of Buhrstone,	1.00	
Sand,	.50	
Factitious puzzolana of M. St. Leger,	.25	Resulting bulk 1.50
do. hydraulic lime do. (unslaked)	.25	
	2.00	

This concrete was placed in a bed eight feet thick, which, owing to a flood in the Seine, was about six weeks in being deposited. Masonry was begun upon it in eight days after its completion, and in six weeks it had the whole pier to support; and before the concrete was four months and a half old it sustained the weight of the pier of the bridge, and of the proof load, without the least appearance of subsidence.

At the Saint Martin canal, where great quantities of concrete were used, the proportions were:

Pebbles,	1.00	Bulk 1.63
Sand,	1.00	
Hydraulic lime,	.33	

In another case, these proportions were used, viz:

Silicious pebbles,	1.00	Bulk 1.34
Tile dust and brick dust,	.28	
Fat lime made from chalk used at the moment of slaking—measured as quicklime,	.56	
Water, more or less,	.53	

Another case.

Rounded gravel about the size of a hazle-nut,	1.000	Bulk 1.15
Mortar,	0.500	
The mortar being composed of brick-dust,	1.00	
Slaked lime, in powder,	1.00	
Sea-sand,	1.00	

After three months immersion in salt water, this concrete sustained a pressure on one end of the mass of 260,000 pounds per square foot of surface without impression. On being broken up, it showed that the gravel was well imbedded in mortar. The void space in the gravel was found to measure 0.35.

Another.

The aqueduct of Guétin, which conducts the Loire canal across the Allier, is composed of 18 arches of $53\frac{1}{2}$ feet span, and of 17 piers of 9.84 feet in thickness. Immediately at one end of the aqueduct are three connected locks, whereof the mass forms the left buttress of the bridge.

The right buttress and its wing-walls, the 17 piers, and the three connected locks, are built on a general "*radier*" or platform, 1594 feet long, 57.42 feet wide, and 5.41 feet thick; on the upper and lower sides of the platform are two guard walls 6.56 feet thick, and 14.76 feet deep—these walls, like the rest of the platform, rising to within 1.64 feet of the level of the water in the river in its lowest state.

The whole of the guard walls, as well as the lower layer of the platform,

for a thickness of 3.28 feet, were formed of concrete deposited in the water. The concrete used amounted to near 22.000 cubic yards.

The operation of depositing the concrete was confined to the 4 or 5 months between the spring and autumn floods; and at the end of the second season it supported the superstructure above described.

The following is the composition of the concrete:

Stone fragments,	1.000	
Mortar,	1.000	
The mortar was composed of sand,		1.50
Hydraulic lime measured in powder,		1.00
Artificial puzzolana of M. St. Leger,		0.50

And the puzzolana was formed by calcining, at a heat not great, a mixture of four parts of earthy clay measured in paste, and one part of fat lime measured in the same way—the mixed pastes being formed into small prisms, dried in the sun, calcined and pulverized.

In order to obtain some evidence of the actual strength of concrete, and to compare several varieties of composition, the experiments contained in the following table were made at Fort Adams: some prefatory remarks are necessary in relation to them.

The *cement* was obtained by taking several casks of hydraulic cement A, of nearly equal energy—emptying them into one heap on the floor, and, after mixing the contents intimately, returning the cement into the casks and heading them all tightly, until they were severally wanted. As the casks were opened, in succession, for use, the quality of the mixture was tried with the test wire, and was found to be very uniform—about half an hour being required for the setting. This cement had been on hand about four months.

The *lime* used was Fort Adams' improved lime. It was slaked to powder by the affusion of one-third its bulk of water, and allowed to stand several days. As it was about to be used, it was reduced to paste and passed through a hand paint-mill, by which it was made very fine. It should be borne in mind that this lime is slightly hydraulic.

The *sand* used was sand No. 1

The larger constituents of the concrete were of four kinds, viz: 1st. *granite fragments*, angular, average weight of each 4 oz.; 2d, *brick fragments*, angular, average weight 4 oz.; 3d. *stone-gravel*, made up of rounded pebbles from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in diameter; and, 4th. *brick gravel*, composed of angular fragments of bricks from $\frac{1}{2}$ to 1 inch in their greatest dimensions. All were perfectly free from dirt, and were drenched with water before mixing them with the mortar.

The measure of the void spaces in the granite and brick fragments was .48; and of the stone gravel and brick gravel, .39.

One set of experiments was made by using, in each case, a measure of mortar equal to the measure of void space—and another set, by using two such measures of mortar.

The mortar was made with as small a quantity of water as possible. On this account, the mixture of the constituents was probably somewhat imperfect; and to this may, in part, be attributed the irregularities observable in the results. The concrete, before ramming, was quite incoherent, especially when only one measure of mortar was used. It was, in every case,

consolidated by ramming into boxes that afforded rectangular prisms of concrete 12 inches by 6 inches by 6 inches.

The prisms were made in December 1836, and being kept in a damp place, safe from frost and accident, were broken in June, July, and August following. In breaking the prisms the two edges of the supports were 9 inches apart, leaving $1\frac{1}{2}$ inch resting at each end: weights were applied, by adding about 60 lbs. at a time, to a scale-pan suspended from a knife edge which bore on the middle of the prism.

Table LXIX.

Trials made in June, July and August, 1837, of the strength of concretes made in December 1836.

The results show the weight in pounds required to break prisms of concrete 12 inches by 6 inches by 6 inches—the distance between the supports being 9 inches.

No.	Composition of the Concrete.	Mortar No. 1. Cement A. 1.00 Sand No. 1. 1.00 Lime	Mortar No. 2. Cement A. 1.00 Sand No. 1. .50 Lime	Mortar No. 3. Cement A. 1.00 Sand No. 1. .50 Lime .25	Mortar No. 4. Cement A. 1.00 Sand No. 1. 1.00 Lime	Mortar No. 5. Cement A. 1.00 Sand No. 1. 1.00 Lime .25	Mortar No. 6. Cement A. 1.00 Sand No. 1. 1.50 Lime	Mortar No. 7. Cement A. 1.00 Sand No. 1. 1.50 Lime .25	Mortar No. 8. Cement A. 1.00 Sand No. 1. 2.00 Lime	Mortar No. 9. Cement A. 1.00 Sand No. 1. 2.00 Lime .25
1	Granite fragments, with 1 measure of mortar	4973	4142	2778	3989	2721	2045	2036	lost	1574
2	do. with 2 do.	4668	4983	5064	4088	5366	1547	3537	1643	1972
3	Brick fragments, with 1 measure of mortar	3242	2117		4127	3254	1788	2136	1567	3649
4	do. with 2 do.	2805	5047	2826	4232	1178	3655	3856	2320	4803
5	Stone gravel, with 1 measure of mortar	1697	1049	1240	1256	1066				
6	do. with 2 do.	2347	4247	2655	1295	3351				
7	Brick gravel, with 1 measure of mortar	5437	6183	3088	lost	4726				
8	do. with 2 do.	6025	5712	5480	3142	2699				
9	Stone fragments, grouted	3278	1846	2012	1158	1178				
10	Brick fragments, grouted,	1634	2305	2869	2726	2770				

Observations on the experiments given in the above table.

It is to be regretted that such discrepancies are to be noted in the table. They are ascribable, in the first place, as suggested above, to the difficulty of bringing the mixture always to the same condition as regards the dissemination of the ingredients, when worked in so dry a state; but, probably, chiefly to the difficulty of filling the moulds always with equal accuracy, and ramming every part with equal force, when using so incoherent a mortar, united with so large a proportion of very coarse ingredients.

Notwithstanding these discrepancies, however, several deductions may be fairly drawn from the table, which, if confirmed by future trials, will be useful.

1st. *When the mortar was made of cement, sand, and lime, or of cement and sand without lime, the concrete was the stronger as the sand was less in quantity.* In 50 comparisons 19 exceptions. *But there may be* 0.50 *of sand and* 0.25 *of lime without sensible deterioration; and as much as* 1.00 *of sand and* 0.25 *of lime, without great loss of strength.*

2d. *A mortar of cement and sand does not seem to be improved by the addition of lime, while the bulk of sand is only equal to, or is less than, the bulk of cement; but as the quantity of sand is further increased, the mortar appears to be more and more benefitted by the addition of a small quantity of lime.*

3d. *Two measures of mortar, in concrete, are better than one measure; that is to say, a quantity of mortar equal to the bulk of the void space does not give as strong a concrete as twice that quantity of mortar.* In 30 comparisons, 7 exceptions. Nevertheless, the strongest example was with one measure of mortar, and it is not unlikely that the deficiency of strength in the other cases resulted from the difficulty of causing all the voids to be accurately filled, when the mortar was a minimum, and the space into which it was forced so small. It is not improbable that the voids may be perfectly occupied, even with one measure of mortar, when the mass of concrete is large enough to permit the full effect of the rammer.

4th. The results of the experiments recommend the several compositions of the table, in the following order, namely:

1.	Brick gravel,	with 2 measures of mortar,	No. 8.
2.	do.	with 1 do.	7.
3.	Brick fragments,	with 2 do.	4.
4.	Granite fragments,	with 2 do.	2.
5.	do.	with 1 do.	1.
6.	Brick fragments,	with 1 do.	3.
7.	Stone gravel,	with 2 do.	6.
8.	Brick fragments, grouted		10.
9.	Stone fragments, grouted		9.
10.	Stone gravel,	with 1 measure of mortar	5.

5th. *It appears that the best material to mix with mortar to form concrete, is quite small, angular, fragments of bricks: and that the worst is small, rounded, stone-gravel.*

6th. *Grout, poured amongst stone, or brick fragments, gave concretes inferior to all, but one, of those obtained from mortars.*

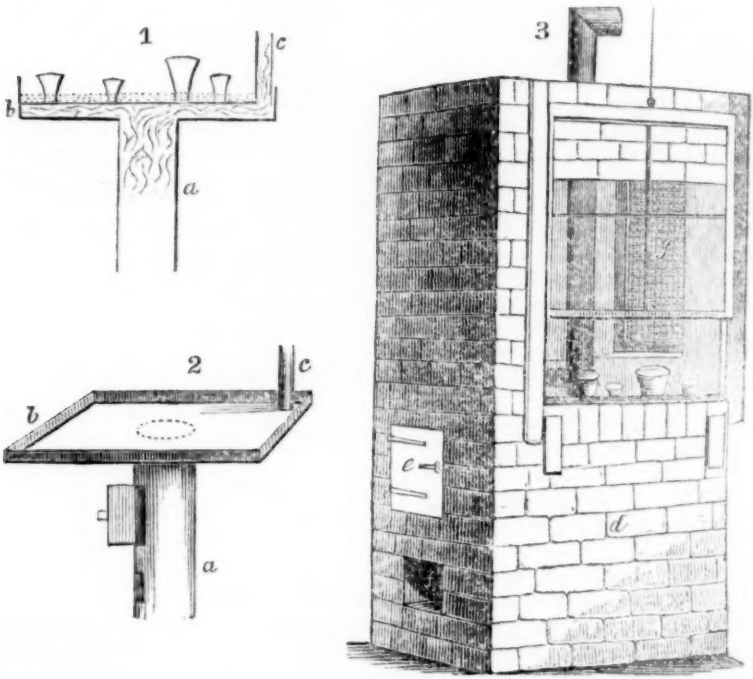
A piece of sound and strong *red sand-stone*, 12 inches by 4 inches by 4 inches, required a weight of 3673 pounds to break it—there being 9 inches between the supports. According to the formula $P = R.\frac{ab^2}{c}$,* prisms of

* In this formula P is the weight causing fracture, c the distance between the supports, a the breadth, and b the depth of the prisms.

this stone, of the size of our prisms of concrete, would require the weight of 12,396 lbs. to break them; whence it appears that the strongest concrete under trial, was, after eight months exposure, half as strong as this sandstone.

Description of a convenient mode of arranging a sand bath.

The practical chemist is always more or less incommoded by the corrosion of the balances and other delicate pieces of apparatus in his laboratory, by the gases and vapours evolved during the processes upon his sand bath. He is moreover subject to uncomfortable heat in the apartment from the necessity of keeping his bath at an elevated temperature. To obviate these inconveniences, I have devised an arrangement the description of which may be useful to those pursuing the subject. The accompanying figures represent the construction of one which I have now in use.



a, figs. 1, 2, represents a nine inch sheet-iron stove, without its ordinary top, while *b* shows a rectangular sheet-iron bath, two feet long by 18 inches wide, made to fit as a top upon the stove; the heated air from the stove is then made to circulate under the sand bath, before it can pass out through the pipe. *c*, fig. 3, represents the stove and sand bath, in place, surrounded by brick-work. *d*, is a chamber in which the stove is placed, and corresponding in size to that of the sand bath. The fuel is introduced into the stove through the hole *e*, and the ashes removed through *f*. The

chamber is made to communicate with the external atmosphere, by holes in the outer wall, against which the arrangement is built. The effect of the body of air circulating around the stove is to prevent entirely the wall of the chamber from becoming heated. *g*, represents a window in the wall of the building occupied by wire gauze, through which the vapours pass out, while their escape into the apartment is prevented by the movable sash, seen in front. Thus at the same time that the operator has completely under his eye and control all his process, he is entirely exempt from the inconveniences of the common forms of sand baths. R. E. Rogers, M. D.

Civil Engineering.

Fifth Annual Report to the Building Committee of the Girard College for Orphans; by Thomas U. Walter, Architect.

Gentlemen:—I have the honour, in conformity with your resolution of the 26th inst., to communicate the following report on the progress of the work during the past year.

The marble work of the centre building is raised to the height of the third story floor; all the arches over the second story are completed, and the quoins are commenced for the vaulting to support the roof;—nearly all the marble required to complete the cell of the building has been wrought;—two of the large antæ capitals are finished, and the workmen are now engaged in executing the other two;—three of the columns on the eastern flank have been raised to their destined height, two more are ready to receive their capitals, and two others are more than half finished;—one of these columns has been fluted and entirely completed, and the fluting of another is nearly finished; several of the large architraves have been delivered; also about 7000 cubic feet of marble for bases, capitals, and columns, beyond what has been used, nearly all of which will be wrought during the winter.

The carpenters are now about commencing the centres for the third story arches, all of which will be ready to set as soon as the spring opens.

The easternmost out building, which embraces the dwellings of the Professors, is nearly completed, and the building nearest the College is in such a state of forwardness as to admit of its being finished (if required,) in three or four months;—I am, however, of opinion, that neither of these buildings should be entirely completed until the time shall have been agreed upon for occupying them, as new buildings deteriorate much faster without occupants than with them;—it would, therefore, be better to keep them in such a state of forwardness that possession may be given at a few weeks notice.

The whole quantity of marble that has been delivered during the past year, amounts to 37,648 cubic feet;—31,974 superficial feet have been wrought and used in the building, and there are now on the ground about 13,500 feet of finished work, 1828 feet that have been sawed principally for ashlar, and 5564 cubic feet in the rough.

There have been 873,150 bricks delivered at the work during the last season, which, together with the 500,000 left on hand from the previous year, make 1,373,150, of which 1,211,150 have been used in the building, leaving 162,000 bricks now on the ground.

All the contracts have been faithfully executed, and every part of the work reflects the highest credit upon the superintendents of the various mechanical branches;—an unusual degree of skill and industry has been

evinced by the workmen, and the most perfect harmony has prevailed in all the departments of the work.

The delivery of marble during the past year has fully equalled our expectations, and there remains no doubt that the contractors will be able to continue the supply as rapidly as it will be required.

The expenditures, from December 31st, 1836, to December 30th, 1837, amount to $181,839 79.

There is now on the ground about $85.000 worth of materials and workmanship which have not yet been used in the building, and which includes capitals, bases, column blocks, and architraves for the portico, the marble for finishing the cell of the main building, and the steps and yard walls of the out-buildings, all of which will be available for the work of next season.

The building is now in a situation to admit of more work being done during the ensuing season than has been accomplished in any one year since its commencement;—the marble work of the cell being nearly completed, there will be nothing whatever to interfere with the progress of the brick work; all the arches of the third story may therefore be constructed, and the building prepared for the roof, before the close of the season,—the columns and architraves of the flank porticoes, and the steps and yard walls of the out buildings, may also be readily finished during the next year, as the whole attention of the stone-cutters will be directed to these objects:—about $285,000 will be required to accomplish this amount of work; it therefore only remains for you to say whether the buildings shall be advanced thus rapidly or not.

A temporary roof has been constructed over the whole of the main building, and the greatest precaution has been taken to prevent injury from frost;—conductors have been made to lead the water from the top of all the arches into sinks in the cellar, for the purpose of preventing the rains that fall on the work during the summer from percolating through the abutments and arches, and saturating the work in the lower stories.

Temporary furnaces for drying and warming the building during the winter have also been constructed, and the warm air introduced into every room in the house, notwithstanding the unfinished state of the work;—this arrangement was deemed expedient, not only to prevent injury to the arches from congelation and consequent expansion by cold, but also for the purpose of evaporating as much dampness from the walls as possible, previous to the occupancy of the building.

The expansible properties of *iron* having been a subject of considerable conjecture in reference to the bands for resisting the lateral pressure of the arches, I was induced to make an experiment for the purpose of discovering the actual difference of temperature produced in the middle of the walls, by the extreme heat of summer and the severest cold of winter.

Although I have never had an idea that any evil could possibly result from the expansion of the iron in question, by an increase of temperature, the materials which surround it being subject to an expansion almost (if not quite,) equal to that of the iron, yet the satisfaction to be derived from positive evidence on the subject is sufficient to give interest to the experiment;—I shall therefore give a brief account of the manner in which it was conducted, so as to enable you to judge how far the result may be relied on.

The place selected for the experiment was the brick wall between the south vestibule and the large rooms;—the thickness of this wall is five feet five inches, and its distance from the south front of the cell twenty-six feet; the sun had therefore full power upon it during the summer, and in the

winter the whole building was covered with a temporary roof:—I should also remark, that the experiment was completed before any fires were made in the furnaces.

On the 23d of September, 1836, the temperature on the work being at 82° Fahrenheit, a self-registering *minimum* thermometer was placed upon the iron band in the middle of the wall, and the work constructed as solidly around it as the rest of the building.

On the 29th of July, 1837, the temperature being again at 82°, a hole was made in the wall, and the thermometer taken out, when it was found that the register had descended to 42° during the intermediate winter, the extreme cold of which was 3° below zero:—thus we find the greatest cold in the middle of the walls to be 42°.

On the 16th of January, 1837, the temperature on the building being 24° Fahrenheit, a self-registering *maximum* thermometer was placed on the iron band in the middle of the aforementioned wall, on the same horizontal line with the other thermometer, and about sixty feet distant from it, a space having been left in the wall when it was built, for the purpose; which space was walled up around the thermometer as firm and compact as the rest of the work.

On the 16th inst., the temperature on the building being again at 24°, the walling was taken out, when it was found that the register in the thermometer had gone up to 61° during the intermediate summer, the greatest heat of which was 94°.

We have therefore 42° for the lowest temperature of the iron bars, and 61° for the highest, making a difference of 19°.

The expansion that an increase of temperature of 180° produces upon malleable iron, is given by Dr. Ure, in his Dictionary of Chemistry,* as follows:

From experiments by Smeaton $\frac{1}{794}$ of its length; according to Borda's experiments $\frac{1}{865}$ of its length; and according to Dulong and Petit $\frac{1}{860}$ of its length.

Mr. Hassler, (of New Jersey,) in his "Account of Pyrometric Experiments," read before the American Philosophical Society, June 29th, 1817,† finds the expansion to be equal to $\frac{1}{798}$ of its length; and in a work on Natural Philosophy, by Biot,‡ we have the experiments of Lavoisier and Laplace, made in 1782, giving an expansion, under the same increase of temperature, equal to $\frac{1}{849}$ of its length.

The trifling difference in these results may be attributed to a difference in the density of the material.

Now, if 180° will increase a bar $\frac{1}{794}$ of its length, (this being the greatest expansion obtained by the foregoing experiments,) 19° will lengthen it only $\frac{1}{7526}$; hence the bands around the rooms of the College, (each being 54 feet long from the points of support,) will be subjected to a difference in their length between the extreme heat of summer and the severest cold of winter, of $\frac{1}{73260}$ or $\frac{1}{12}$ of an inch.

This being the actual difference produced in the length of the iron bands, by the greatest change of temperature to which they can be subjected, it remains for us to consider the expansibility of the materials with which they are surrounded.

A table on the expansion of different kinds of stone, &c., from an increase

* Ure's Dictionary of Chemistry, page 272.

†Transactions of the American Philosophical Society—new series—Vol. I., page 227.

‡ Physique de Biot, Vol. I.

of temperature, is given by Mr. Alexander J. Adie, civil engineer, in a paper read before the Royal Society of Edinburgh, on the 20th of April, 1835,* in which he makes the expansion produced upon bricks by 180° of Fahrenheit, equal to $\frac{1}{1818}$ of its length, or $\frac{1}{26}$ of an inch in 54 feet under an increase of temperature of 19°.

If, therefore, the maximum expansion of one of the iron bands in the walls of the College is $\frac{1}{12}$ of an inch, and the brick work surrounding it $\frac{1}{26}$, the difference is then reduced to nearly $\frac{1}{25}$ of an inch:—but if we consider that the variation of temperature in the interior of the wall is only 19°, while the exterior is subjected to the extremes of heat and cold, it will be obvious that the aggregate expansion and contraction of the brick work is even greater than that of the iron.

From these considerations, it is evident that not the slightest injury can possibly result from the use of iron in the construction of the College.

I am, gentlemen, very respectfully, your obedient servant,

THOMAS U. WALTER, Architect.

Girard College, December 30th, 1837.

To JAMES HUTCHINSON, ESQ.
Chairman of Building Committee, Girard College for Orphans.

Physical Science.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Report of some Meteorological Observations made at Frankford Arsenal, near Philadelphia. By Captain A. MORDECAI, of the Ordnance Department.

1. *Of the Temperature.*

In a former paper on this subject [Journal of Franklin Institute, Vol. XIX. p. 7] I gave the results of hourly observations of the thermometer during one year, from which were deduced the hours of daily mean temperature, and of daily maxima and minima in each month, and it was also shown that the mean temperature derived from the daily extremes is the same as that derived from hourly observations. As the temperature changes very slowly near the maximum and minimum points, the observation of the extremes of daily temperature is little subject to error, and we have thus a method of testing the accuracy of the deductions previously made, as to the hours of observation for the mean temperature of the day. For this purpose I have made, during two years, four daily observations of the thermometer; two for the maxima and minima, and two for the means. The hours selected for the observations, and the results for each of the years ending 30th April, with the average for the two years, are presented in the following table.

*See Journal of the Franklin Institute of the State of Pennsylvania, Vol. XX. page 200.

Table of Mean Temperature.

	Hours of Observation.				1836, 37.			1837, 38.			Two Years.		
	For the Means		For the Extremes.		Mean temperature deduced from			Mean temperature deduced from			Mean temperature deduced from		
	A. M.	P. M.	A. M.	P. M.	daily means.	daily extremes.	4 daily observations.	daily means.	daily extremes.	4 daily observations.	daily means.	daily extremes.	4 daily observations.
	H. M.	H. M.	H.	H. M.									
May, . . .	8.30	7.45	4.	2.30	62.05	61.51	61.78	59 82	59.53	59.82	60.94	60.52	60.80
June, . . .	8.	8.	4.	2.30	64.03	64.61	64.32	67.75	67.63	67.01	65.89	66.12	65.76
July, . . .	8.	8.	4.	2.30	72.83	73.49	73.20	71 60	72.41	72.01	72.22	72.95	72.61
August, .	8.	8.	4.	2.30	76.60	68.32	67.95	70.34	71.08	70.90	68.97	69.66	69.45
September,	8.30	7.30	5.	2.30	65.94	67.38	66.87	61.97	62.50	62.27	63.96	64.94	64.57
October, .	9.	7.	6.	2.30	48.44	48.36	48.58	54.17	54.36	54.54	51.32	51.36	51.56
November,	9.	7.	6.	2.30	40.33	40.78	40.82	45.31	45.85	45.62	42.82	43.32	43.22
December,	9.	7.30	6.	2.30	32.35	32.47	32.62	35.45	35.30	35.39	33.90	33.99	34.00
January, .	9.	7.30	6.	2.30	27.81	27.40	27.68	36.29	36 80	36.63	32.05	32.10	32.15
February, .	9.	8.	6.	2.30	31.74	31.86	32.21	24.35	24.58	24.59	28.05	28.22	28.40
March, .	9.	8.	5.	2.30	38.57	38.80	38.87	40.37	40.72	40.58	39.47	39.76	39.73
April, . .	9.	8.	5.	2.30	47.92	47.98	48.06	46.00	46.16	46.13	46.96	47.07	47.09
12 months.					49.97	50.24	50.25	51.11	51.41	51.29	50.54	50.83	50.77

This table shows the mean temperature deduced, 1st, from two daily observations at the hours stated in the first and second columns; 2nd, from two observations at the hours stated in the third and fourth columns; 3rd, from the four daily observations combined. These results, agreeing very nearly with each other, show that the hours chosen for the observations of the mean temperature are nearly correct; but in comparing the results of the morning observations for the mean with those of the evening, (results which it is not thought necessary to show separately in the table,) I find that the former give generally (and especially in the summer season,) too low an average, and the latter a little too high; the excess in the one case not compensating for the defect in the other; as the general average is seen to be somewhat too low, when compared with the general mean of the ex-

tremes. A closer approximation to the true times of mean daily temperature could hardly have been expected, from a register of only one year's observations, but by the aid of the above table we may correct the previous deductions, and we shall probably find the true times for observing the mean daily temperature to be nearly as follows, viz:

	h 9. A. M.	h 8. P. M.
For February, March, April, and May,		
June, July, and August, . .	8.30	8.
September, October, November, Dec. and Jan.	9.00	7.30

I subjoin a statement of some general results of the three years observations.

	°
Mean temperature of the year ending April 30th, 1836	49.21
Maximum observed July 15th, 3 and 4 P. M. .	89.50
Minimum observed February 6th, 5 and 6 A. M. .	–7.00
Extreme range of temperature . . .	96.50
Mean temperature of year ending April 30th, 1837, .	50.24
Maximum observed July 9th, 2½ P. M. . .	89.00
Minimum observed January 3d, 6 A. M. . .	6.00
Extreme range of temperature . . .	83.00
Mean temperature of year ending April 30th, 1838. .	50.77
Maximum observed August 30th, 2½ P. M. .	89.00
Minimum observed February 21st, 6 A. M. . .	10.00
Extreme range of temperature . . .	79.00
Average of three years.	
Mean temperature, ...	50.07
" Maximum, ...	89.17
" Minimum, ...	3.00
" Yearly range, ...	86.17

2. *Of the Rain.*

At the same time with the thermometric register, I began a series of observations with a view to furnish data for discussing the question of the relative quantities of rain received on equal surfaces at different heights above the ground. For this purpose two stations were chosen; one on the ground, in an open garden; the other on the top of a tower attached to the principal store house at the Arsenal, and about 250 feet in a south-easterly direction from the first. The tower is about twenty five feet square; it has a flat roof surrounded by an open balustrade about three and a half feet high, and the roof is nearly on a level with the ridge of the building to which the tower belongs; the tower is on the west side of the building, the ridge of which runs north and south. The prevalent winds are N.E. and N.W. The roof of the tower is fifty-two feet above the ground at the first station, which latter is about twenty-three feet above low water in the Delaware. The surrounding country is open and nearly level for more than 100 miles towards the north and west, and on the south and east no high lands intercept the winds from the Atlantic. The same kind of rain gauge was used at each station: it consists of a cone of tin to the base of which is attached a short cylindrical rim 5 inches in diameter, the water received in which passes through an opening of $\frac{3}{16}$ of an inch at the apex of the cone, into a cylindrical receiver to the neck of which the conical part is closely fitted by a collar; the whole is painted white and enclosed in a wooden box likewise painted white.

The water thus collected is measured in a glass tube graduated so as to allow of reading less than $\frac{1}{1000}$ of an inch of rain. The measurements were

punctually made immediately after each rain, but the evaporations from these gauges is so slight that no appreciable error would have arisen from permitting the water to stand in them many days.

To test this experimentally the two gauges were placed side by side during the month of July, 1837; it rained eight times during the month, and half of the whole quantity of rain fell before the eighth day: one of the gauges, measured after each rain, gave a total of 3in.677; the other at the end of the month gave 3in.680.

To measure the snow, which would fill the conical part of the gauge without finding its way into the receiver, I used two other gauges of the same diameter as the first at the top, but widening downwards and terminating in a receiver of sufficient capacity to contain all the snow that could enter it during one storm. These gauges, whilst in place, were measured for the rain as well as the snow, and although the individual results did not always correspond, the total for each month generally confirmed that obtained from the rain gauges.

In consequence of the drifting of the snow it may be thought that the quantity received in an open vessel cannot afford an accurate measure of that which falls; but the general agreement in the results obtained from the two gauges at each station, in the frequent cases where the snow in both could be measured, leads me to think that the error from this cause is not great.

Under the head of temperature in the following table, are shown the mean temperature of each period, and the average daily range of temperature, or mean of the daily maxima and minima, derived from the observations referred to in the preceding part of this paper. The column of "ratios" shows the proportion of the quantity of rain received on the tower to that received on the ground, the latter quantity being represented by 1000. The height of the tower is not sufficient to admit of an intermediate place of observation between it and the ground, and there is no higher point attainable at the arsenal: having then but one station above the ground, these results do not, in themselves, afford the means of discussing the laws of diminution of rain at various heights, but they may be useful for that purpose in conjunction with other observations of a similar kind which may have been made at Philadelphia, or its vicinity. Some such were made by Prof. A. D. Bache, on the top of a shot tower, in Philadelphia—I proceed to state such remarks as are suggested by an examination of table I.

1. Additional evidence is afforded to the now established fact of a diminution in the quantity of rain at different heights above the ground. A remarkable deviation, however, from this law is seen in the results of the winter observations in 1835–'36, where in the months of November, December, January and February, the greatest quantity of rain was received at the *upper* station; that winter was very cold, (the thermometer marking at one time 7° below zero,) and there fell a great quantity of snow, the measurement of which is, as before observed, included in the general statement; but the anomaly cannot be attributed to the accidental *drifting* of the snow, since it is equally marked in cases where little or no snow fell, and besides it would be much more apt to drift into the lower gauge than the upper. In the two succeeding winters, which were milder, with less snow, this anomaly is not observed, the diminution in the second winter being greater in the cold months than in the warm.

TABLE No. I—*Results for three years.*

	1835–'36.			1836–'37.			1837–'38.			Average of three years.				
	Mean Temperature.	Rain.		Mean Temperature	Rain.		Mean Temperature.	Rain.		Temperature.		Rain.		
		Ground.	Tower.		Ground.	Tower.		Ground.	Tower.	Mean.	Mean range.	Ground.	Tower.	Ratio to 1000.
		in.			in.			in.				in.	in.	
May,	59.18	2.196	2.050	61.83	1.929	1.695	59.82	4.351	4.001	60.28	19.35	2.825	2.582	914
June,	67.78	4.231	3.936	64.33	7.665	7.137	67.01	2.814	2.737	66.37	14.06	4.903	4.603	939
July,	71.58	6.159	5.861	73.20	1.917	1.835	72.01	3.677	3.356	72.26	14.03	3.918	3.684	930
August,	68.46	2.494	2.289	67.95	2.356	2.297	70.90	4.579	4.250	69.10	13.87	3.143	2.935	934
September,	59.43	2.900	2.725	66.87	1.906	1.814	62.27	2.228	2.126	62.86	14.10	2.344	2.221	948
October,	56.20	1.169	1.051	48.58	2.929	2.649	54.54	0.569	0.524	53.11	16.02	1.555	1.408	906
November,	44.98	2.862	2.906	40.82	2.921	2.792	45.62	2.386	2.248	43.81	13.06	2.723	2.648	972
December,	29.90	2.799	2.987	32.62	3.850	3.385	35.39	2.367	2.289	32.64	12.42	3.005	2.887	962
January,	27.68	5.138	5.407	27.68	1.745	1.598	36.63	1.721	1.600	30.66	11.96	2.867	2.869	1000
February,	23.07	2.498	2.662	32.21	2.809	2.651	24.59	1.549	1.468	26.62	12.85	2.289	2.260	987
March,	33.58	1.420	1.390	38.87	3.425	3.332	40.58	2.242	2.173	37.68	15.68	2.362	2.298	973
April,	48.65	3.019	2.943	48.06	1.969	1.850	46.13	2.841	2.739	47.61	16.16	2.610	2.510	962
Spring,	47.14	6.635	6.383	49.59	7.323	6.877	48.84	9.434	8.913	48.52	17.06	7.797	7.390	948
Summer,	69.40	12.884	12.086	68.49	11.938	11.239	69.97	11.070	10.343	69.24	13.99	11.964	11.222	938
Autumn,	53.54	6.931	6.680	52.09	7.756	7.255	54.14	5.183	4.898	53.26	14.39	6.622	6.277	948
Winter,	26.88	10.435	11.056	30.84	8.404	7.634	32.20	5.637	5.357	29.97	12.41	8.161	8.016	982
6 warm months,	63.77	19.149	17.910	63.79	18.702	17.397	64.43	18.218	16.994	64.00	15.24	18.688	17.433	933
6 cold months,	34.64	17.736	18.295	36.71	16.719	15.608	38.16	13.106	12.517	36.50	13.69	15.856	15.472	976
12 months,	49.21	36.885	36.205	30.25	35.421	33.005	51.30	31.324	29.511	50.25	14.46	34.544	32.905	953

The only notice which I have seen of such an excess of rain at the upper station is in the Journal of the Franklin Institute, vol. XVII, p. 286, where it is recorded that at Kinfaun's Castle, a greater quantity of rain

was received, in 1834, in a gauge elevated 160 feet above the ground, than in one on the ground; the difference in this case was very small, (only $\frac{15}{100}$ of an inch,) but the observation is not the less remarkable, for at such an elevation a difference of at least one third in favor of the lower gauge might be expected.

2. The average quantity of rain received on the ground is 32½ inches in a year; the average quantity fallen in the six warm months has been greater than in the six cold months. The quantities fallen in Spring and Autumn, have been nearly equal, but the average in summer has exceeded that in Winter by nearly *one fourth*. Here it should be remarked, however, that this great disproportion is occasioned chiefly by the unusually great quantity of rain, (nearly nine inches,) which fell between the 28th of May and the 30th of June, 1836.

3. The average diminution of quantity at the height of 52 feet is about 5 per cent; and this result of the three years observations agrees very nearly with that which is obtained from an average of the rain that has fallen without wind or with very light winds, when the observations may be considered least liable to error.

4. The diminution at the upper station is, in the three years, and in the general average, greater in Summer than in Winter. This result also is inconsistent with those of previous observations. In the reports of the British Association for the advancement of Science, (third and fifth meetings.) the present subject is discussed mathematically by Prof. Philips, from the results of three years observations at York, from which he has deduced formulæ to represent the relation which the diminution of rain bears to the height of the station and to the temperature of the season; but as his observations gave the diminution greatest in the cold season, he makes the *amount* of diminution dependant on the temperature of the season *inversely*, whilst here it appears to vary with the temperature *directly*.

5. The column of mean daily range of temperature in the table, is given as a substitute for the observation of the mean dew point in ascertaining the relative dryness of the air at different seasons; the dryness being considered directly proportional to the mean range of temperature. Here again, if my observations are correct, the law of diminution is different from that which obtains at York; for the diminution of rain as we ascend seems here to be greatest in the dryest season, or when the mean range of temperature is greatest; whereas at York it bears an *inverse* relation to the mean range. The latter relation seems the more probable, and accords with the natural solution of the question, which attributes the increase of the quantity of rain in descending to an augmentation of the drops in passing through a warm and more moist tract of air: I am, therefore, inclined to doubt whether some disturbing cause, that may impair the correctness of the observations, may not have escaped my notice. But the laws of variation in the quantity of rain may be, and probably are, very different in our climate from those which hold good in England, and my observations having been carefully made, will serve, I hope, to throw some light on the subject.

In order to ascertain whether such a disturbing cause as I have referred to could be found in the direction of the wind, at the time of the rain, I have arranged the results of the observations with reference to the course of the wind as in the following table.

TABLE II—*Average quantity of rain from each quarter.*

1835 to 1838.	RAIN.									
	N. E.		S. E.		S. W.		N. W.		TOTAL.	
	Ground.	Tower.	Ground.	Tower.	Ground.	Tower.	Ground.	Tower.	Ground.	Tower.
May,	2.153	1.978	0.153	0.146	0.400	0.372	0.116	0.086	2.825	2.582
June,	3.315	2.155	0.916	0.914	1.222	1.162	0.447	0.384	4.903	4.603
July,	2.931	2.766	0.166	0.162	0.572	0.521	0.248	0.235	3.918	3.684
August,	1.492	1.423	0.219	0.196	0.628	0.596	0.804	0.720	3.143	2.935
September,	1.515	1.444	0.515	0.487	0.273	0.251	0 041	0 039	2.344	2.221
October,	0.749	0.678	0.211	0.197	0.534	0.479	0.061	0.054	1.555	1.408
November,	1.670	1.695	0.286	0.257	0.571	0.529	0.196	0 187	2.723	2.648
December,	0.940	0.913	0.658	0.612	0.631	0.521	0.776	0.841	3.005	2.887
January,	2.290	2.318	0.	0.	0.348	0.322	0.229	0.229	2.867	2.869
February,	1 916	1.928	0.134	0.111	0.235	0.219	0.004	0.002	2.289	2.260
March,	1.955	1.910	0.253	0.250	0.154	0.138	0.	0.	2.362	2.298
April,	1.507	1.451	0.	0.	0.757	0.729	0.346	0.330	2.610	2.510
Six warm months,	11.158	10.442	2.180	2.099	2.626	3.381	1.717	1.515	18.688	17.433
Ratios,	1000	936	1000	961	1000	932	1000	884	1000	933
Six cold months,	10.278	10.215	1.331	1.210	2 696	2 458	1.551	1.589	15.856	15.472
Ratios,	1000	994	1000	909	1000	912	1600	1.024	1000	976
Twelve months,	21.436	20.657	3.511	3.312	.6325	5 839	3.299	3.107	34.544	32.905
Ratios	1000	963	1000	943	1000	923	1009	942	1000	953

From this table it would appear that the ratio of the quantities of rain at different heights is not much influenced by the mere *direction* of the wind, for the ratios of the quantities received from the same direction in different seasons do not correspond. The relative ratios in different seasons, from different directions appear anomalous, but it is to be remarked that the quantity of rain received at one time from other than the N. E. direction is, generally speaking, so small that the error of measurement, or of accidental variation, is more sensible.

In comparing the individual observations, I observe that the *force* of the wind exercises a decided influence on the ratio of the quantities of rain:

the diminution in the upper gauge being generally greater in proportion to the violence of the wind; in one instance, of a violent storm from the S. W. the diminution was as great as 36 per cent. This effect must be attributed chiefly to eddies from the roof of the building, preventing the rain from entering the gauge, and from this cause it is probable that we shall arrive at a correct mathematical solution of our question only by taking account of the rain which falls in calm weather, or accompanied by very light winds. At the same time I must remark that in analysing the second and third years' observations, omitting those in which the rain was accompanied with high winds, I do not find that the results differ materially from those given by the general average for those years.

Table II is interesting as exhibiting the average quantity of rain which has reached us in each of the last three years, from different quarters. Thus we see that *two thirds* of the whole quantity has come from the N. E., about *one-sixth* from the S. W., and *one-twelfth* from each of the other quarters. The numbers in the table are the results of 260 observations, being for each of the three years an average of 87, viz:

From N. E.	43	observations,
S. E.	7	"
S. W.	24	
N. W.	13	"
Mean total	87	"

The average number of days in each year on which rain or snow fell is 117.

Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN SEPTEMBER, 1837.

With Remarks and Exemplifications by the Editor.

267. For an improvement in the mode of *Working Pumps for Pumping Ships, &c.;* David Gay, Bath, Lincoln county, Maine, September 8.

The pumping is to be effected by the rolling of the vessel, and to effect this there is to be a vertical shaft of iron, having a step, and a bearing in a suitable frame. Towards the upper end of this shaft there is to be a cast iron weight, sustained by means of arms, which weight is to cause the shaft to revolve. Near the lower part of the shaft is a horizontal wheel, firmly attached, and sustaining seven, or any other suitable number of, friction wheels, which may be one foot each in diameter; they are to revolve on centre pins passing through the face of the horizontal wheel, near its periphery, and, of course, projecting nearly one half their diameters beyond said wheel. As the shaft revolves, or vibrates, these friction wheels are to work three pump brakes, with projecting arms from which they are to be kept in contact, by means described in the specification. As the vessel will not be always rolling, a hand lever is attached to the apparatus, to work the pumps when necessary. The claim is to "the application of the weight to the shaft of the eccentric wheel for giving motion and action to the pistons of the pump, by the rolling or pitching of the ship, or vessel, at sea, or in rough water; and combining therewith a hand lever for working the pump by hand when the ship has not sufficient motion."

There have been various devices, patented and unpatented, for working

pumps either by the rolling, or the way, of a vessel, possessing, of course, various degrees of merit. We do not think, however, that the one before us, although denominated an improvement, will justify the name; it must itself, we apprehend, be greatly improved, before it will perform its office well, or do more than occasionally deliver a few quarts of water.

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268. For an improvement in the mode of constructing the *Hubs of Carriage and Waggon Wheels for containing Oil;* Abraham Randall, Vernon, Oneida county, New York, September 8.

These hubs are to be of cast iron; and it is proposed to cast them in three pieces, which are to be united together by means described in the specification. The main feature of novelty is the casting the parts hollow, so as to form large reservoirs for oil, which is to be poured in through openings closed by screws. Through the centre tube or box, which receives the axle, there are to be holes, communicating with these reservoirs, so as to keep up a continued lubrication. The claim is to "the casting of hubs with hollow compartments for containing the oil or other lubricating matter, having holes communicating with the axle; the compartments covered by screw boxes, substantially as above described."

Reservoirs for oil, in the hubs of wheels, are well known applications; the novelty, therefore, of the foregoing plan exists only in the particular way in which these are arranged and constructed, as making a part of a cast iron hub.

•For a machine for *separating Smut from Wheat;* Benjamin M. Smith, Rochester, Monroe county, New York; Patent dated August 1.

The claim to this machine is as follows:

"What I claim as my invention is the constructing of a machine for cleaning wheat or other grain, having a shaft with revolving disks, the upper surfaces of which are made rough by punching, or otherwise; which disks are surrounded by a case, the interior of which is also made rough by punching; and by the insertion of metallic points in alternate sections; the whole being constructed, and operating, substantially in the manner set forth. I also claim the vanes, as combined in this machine, and the particular manner of forming the step." The grain is to be let in at the upper end of the machine, whence it falls through a hole upon the upper revolving plate, where there are arms, or vanes, which throw it forcibly against the shell, or case. These vanes are to create a wind, by which the process of cleaning is to be aided. There also are to be similar vanes on the lower disk, which are to operate in a similar manner. One half of the outer case, in segments, is to be of sheet iron, punched, like a grater, from the outer to the inner sides, leaving numerous openings through which the smut, and other dust, may escape. The particular manner of forming the step consists in the surrounding it with an oil cup, within which oil is constantly kept, and upon which there is a cover to keep out dust. Analogous contrivances have been used, but probably not such as could be deemed identical.

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269. For a machine for *Moulding and pressing Bricks;* Nathaniel Adams, Cornwall, Orange county, New York, September 8.

A cylindrical box is placed vertically, to contain the clay to be moulded. The bottom of this box consists of bars of metal at suitable distances for the clay to pass through to the moulds beneath, which are slid in under the bars, an empty set of moulds being made to push a full set out.

•The numbering of this patent is omitted, it having been noticed in the last list, by mistake. The present notice, however, is more full.

Within the cylindrical box, a vertical shaft is made to revolve by any suitable power, and upon this is placed what is called a circular inclined plane which consists of a plate of metal fastened to the shaft, and extending out so as nearly to touch the box; this plate forms a single thread of a screw, and by its revolution causes the clay to descend. An intermitting motion is given to the shaft, to prevent the descent of the clay during the time of changing the moulds; the contrivance for effecting this we cannot now describe, but it manifests ingenuity. The claim is to "the combination of the parts of said machine in the manner above described, or in any other manner substantially the same, for the purpose aforesaid; but no part separately, or independently of this combination."

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270. For an improvement in the construction of *Door Locks;* Turner Whitehouse, Boston, Massachusetts, September 8.

The whole of the proposed improvement consists in the employment of a number of friction rollers within the lock, for the purpose of making it work easily. There are two, for example upon the lock bolt, for the key to operate against; one larger one upon the dog, or tumbler, to receive the lift of the key; another upon the dog, or tumbler, for the spring to play against, which forces it down. The tumbler of the latch bolt, also, plays against friction wheels, there being three devoted to this object. The claim is to "the application of the several friction wheels, and the adaptation of the various parts of the lock for the reception of these friction wheels, as represented in the drawings."

One thing must be perfectly plain, namely, that by this application of friction wheels a lock is rendered much more complex than without them, whilst the main purpose of a lock, security, is not in any degree promoted; its liability to become foul, and to get out of order, will also be increased. The gain we think very trifling, as in a well made lock, the amount of friction is very small, so small that it is scarcely desirable to lessen it.

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271. For a *Non-radiating hot air Stove;* Benjamin Blaney, Boston, Massachusetts, September 8.

There is too much complexity in this stove for verbal description. In the drawing of it there are six different figures explanatory of its various arrangements. The claims are to "the application of the cold air to the inner surface of the outer case, over the whole space from the base to the top of the stove, by the mode in which it is admitted through the air box into the cold air chamber, and caused to circulate between the outside case and the loose case, and between the loose case and the perforated case, before it passes through the perforated case into the hot air chamber, to act upon the heated cylinder. Also the application of the loose case to the hot air stove for the purpose of preventing the direct rays from the heated cylinder acting through the perforations upon the outside case, in the manner described."

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272. For improvements in *Window Sash Springs* for upper sashes; Henry Hammond, Lewisburg, York county, Pennsylvania, September 8.

This improvement consists merely in so forming a spring for sashes, as that it may be applied to the upper as well as to the lower sash; the kind of spring alluded to is that which catches into notches, and holds the sash at various heights, having a thumb piece by which it is pressed back. The

claim made is to "the particular form and manner of applying the spring for the upper sash, as described."

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273. For an improvement in the construction of *Stoves;* George F. Hopkins, city of New York; Patent dated March 8.

This stove is made of cast iron, is open in front, and has a grate for coals which may be removed, for the purpose of burning wood. The sides of the stove are vertical, and are segments of a cylinder. There are two doors which are also segments of cylinders; which doors when drawn together close the front, and when opened, slide in grooves and run back so as to cover the side plates, with the curve of which they correspond. The back plate of the exterior of the stove is flat, and two or three shelves project out from it, for the purpose of sustaining articles which it is desired to keep warm. At the back of the fire place there is a cast iron plate, reaching from the top to the bottom of the stove. This also is a segment of a cylinder, standing with its convex sides towards the fire. Between the two back plates there is a space of about four inches, constituting a chamber, or reservoir, of heated air. The claims are to;

"1st. The employment of sliding doors, running in curved grooves formed in the upper and lower plates, to receive them, as set forth.

"2nd. The placing of metallic shelves against the rear plate of the stove, in the manner and for the purpose specified.

"3rd. The form and construction of the chamber essentially in the manner and for the purpose specified."

This stove is described with special care and minuteness, and the virtues of its construction and arrangement, dwelt on with much complacency, and that in several instances in which our perceptions have been too obtuse to enable us to discover the difference between the parts described and analagous parts in numerous other stoves. Judging from the drawing the stove has a neat appearance, and with the same supply of fuel which furnishes a given portion of heat in some other stoves, we have no doubt that this would behave equally well.

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274. For an improvement in the *Steering Apparatus for Ships, &c.* called Nicholson's steering wheel and guide; Samuel Nicholson, city of Boston, September 12.

The tiller is to be fixed in the rudder head, so as to stand a little above the deck, and upon the deck there is to be laid a frame, or platform, having a curved edge, adapted to the sweep of the end of the tiller. The curved edge of this frame is grooved so as to receive a tiller rope; this part of the apparatus is called the guide. Near the end of, and upon the tiller, there are to be raised two vertical posts, one behind the other, to support a common upright steering wheel, and the wheels by means of which it is to operate upon the guide. The steering wheel is fixed upon a shaft which has its bearings in the two posts; which shaft projects out through the hind post to receive the wheel. Upon this same shaft, between the posts is fixed a toothed driving wheel of six inches diameter, which mashes into a wheel below it of eighteen inches diameter, the shaft of which is also sustained by bearings in the two posts. Upon the shaft of this last wheel there is a drum, or whirl, of the same diameter with the wheel, grooved, and sufficiently thick, to receive the turns of the tiller rope, which is to be wound round it. On the under side of the tiller, small grooved pulleys, or sheeves, are so ar-

ranged as to conduct the tiller rope directly upon the grooves of the guide. The outer ends of this rope are attached to the hind part, or back of the guide, which is a semicircle, or nearly so. This constitutes the general arrangement of the apparatus, and it will be seen that by turning the steering wheel the tiller may be carried round. The patentee points out various modifications of his apparatus, and then says, "What I claim as my invention is the fixed and permanent guide, distinctly, and by itself; and then the combination of the guide with the cog wheels and cylinder, forming the machine above described.

"The advantage gained by the guide is the prevention of slack in the steering rope, so that where the tiller traverses the deck, the deck is kept unincumbered for the passage of men, spars, &c.; and at all times the movement of the steering wheel is immediately felt by the helm."

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275. For improvements in the *Machine for Pressing Bricks*; Andrew F. Mervine, St. Louis, Missouri, September 12.

The particular mode of arranging and guiding the levers in this press would require either an engraving or a very long description, to make them known; not because the machine is itself specially complex; but because an actual form which may be perceived and understood by a glance of the eye, may not be communicable in words, or may require too much circumlocution. The claims made are to certain peculiarities of arrangement.

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276. For *Machinery for making Bodies of Hats of Fur;* Henry A. Wells, J. James, and R. H. Peck, city of Brooklyn, New York, September 20.

This invention consists in the application of steam, issuing through openings in suitable tubes, upon a web of fur, which is wound upon cones by an improved apparatus, in which the transverse, vibrating, and rotary motions are so managed as to cause the various required operations to be simultaneously performed; the whole being "connected with the other operations provided for by said machinery, to form and harden a hat body, and prepare the same for the sizing operation, in a manner much easier, better, more expeditious, and cheaper, than has heretofore been done in any other way."

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277. For a *Stove, for Heating and Cooking;* Philip Wilcox, Springfield, Hampden county, Massachusetts, September 12.

The claims are to certain things in which this stove is considered to differ from others, but they are not of a character to be made known verbally. The attempt to do this would generally produce more fatigue than edification. When patentees choose to furnish cuts, corresponding with their specifications, and exhibiting what they deem the characteristics of their inventions, we will insert them; in other cases we shall be compelled, most commonly, to "read them by their titles."

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278. For an improved *Planing Machine;* Alonzo G. Hull, Brooklyn, Kings county, New York, September 20.

In this machine the planing is to be effected by cutters placed upon the faces of wheels, or disks, which revolve vertically, as is the case with many other planing machines, and which, therefore, is not claimed. The pa-

tentee conceives, however, that his manner of combining the respective parts is substantially new, and makes claim to this particular combination. The planing is not to be effected by cutters upon a single wheel or disk, but on two or more in succession; against which the stuff is fed by means of an endless chain. The first of these wheels reduces the stuff in the manner of a jack plane, and it is subsequently smoothed by the others. The using of two or more such wheels, operating successively is claimed. The cutters on the reducing wheel are peculiar in their construction, there being four, or any other convenient number of, cutters set in one stock, so as to cut successively to different depths, in advance of each other; there is also a single cutter described and claimed, which has offsets causing it to operate in a manner analogous to those above noticed. Upon the smoothing wheel there are long cutters, or knives, extending from near the centre to its periphery, in a direction making an angle with the radii of the wheel. There are also shorter cutters arranged near the periphery, and face plates, to determine the thickness of the shaving; these are also claimed.

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279. For a machine for *Breaking and Cleaning Hemp and Flax;* D. M. Langley, and S. Davis, Westbrooke, Cumberland county, Maine, September 21.

In this machine there is a cylinder, the periphery of which is formed of slats passing from head to head, and resembling in form the slats on the bed of the ordinary break. This cylinder is placed in a frame so that it may revolve vertically, a small portion of its periphery projecting above the cheeks of the frame within which it revolves. There are two endless feeding aprons, one on each side of the cylinder, their upper surfaces being even with the top of the frame; upon these the flax or hemp to be broken is placed, and it is fed to the breaking cylinder by the revolving of these feeding aprons. A beater having three or more blades upon it, adopted to the spaces between the slats of the cylinder is hung by its outer end in a frame which stands at right angles to the main frame; and the outer end of this being acted upon by revolving cams, or lifters, causes the beater to rise, and allows it to fall by its gravity. By suitable gearing the cylinder of slats is carried round by an intermitting motion, as also are the rollers which carry the endless aprons; two blows are given by the beater between each movement of the cylinder. There are two pressing rollers, one over each of the inner rollers of the endless, or feed aprons, and between these and the aprons, the hemp or flax lies, they serving by their weight to hold it down as it is fed. The claim is to "the combination of the revolving cylinder breaker, with the beating breaker, and the aprons, as above specified."

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280. For an improvement in the *Machine for cutting Veneers;* Joseph Skinner, Stockbridge, Berkshire county, Massachusetts, September 29.

The description of this machine is of great length, and has reference to numerous figures in the drawings, of which we cannot attempt to give a general epitome. The veneers are to be cut by a knife made to traverse backward and forward, and the stuff to be cut is pressed by a roller along the point, or line, on which the knife operates, so as to prevent the cracking of the wood in advance of the knife. By this mode of cutting there is not any stuff lost, and the veneer is so thin that it may be rolled out of the way, as the cutting proceeds. The inventor says, "now what I claim as

my invention, is the use of a slide, or roller, in conjunction with a knife, or cutting tool, substantially as above described, for cutting veneers, or thin pieces of wood, for all useful purposes: the object of said slide, or roller, being so to compress the wood during the operation of cutting, as near as possible to the point of impact of the edge of the knife, or cutting tool, as to prevent the wood from parting, or separating in the grain, in advance of the knife."

"A knife and compressing slide, or roller, for cutting upon the above described principle, may be greatly varied with respect to both form and movements. The mechanical arrangements necessary for making the fundamental principle available, may be greatly varied, so as to cut either endwise, obliquely, or from a round log. Hard timber may be softened by steam, or otherwise heating, to facilitate the cutting the veneers, and to render them more pliant and yielding."

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281. For an improved *Pantaloon Measure*; Edwin Grimston, Danvers, Essex county, Massachusetts, September 21.

It will appear from the claim made that this instrument is constructed upon philosophical principles; the claim is in the following words:

"What I claim as new in this instrument in the measuring for Pantaloons, is the particular construction and arrangement of the respective slides, with their appendages, working upon a perpendicular bar, in the manner described; with the application thereof, to the ascertaining of the curves of the leg and body, by measuring their deviation, precisely, from a perpendicular, or other fixed line."

A vertical rod, four feet long, is to rise from one side of a horizontal platform placed upon the floor; upon this vertical rod there are four slides which may be slid up and down upon it, and be tightened by screws at different heights. These slides carry others which pass through mortises in them, and slide horizontally; the whole being graduated into inches and parts of inches. The person to be measured stands upon the platform so that the outside of the calf of the leg and also the hip, or body, just touch the vertical rod. The first slide is then placed opposite the hollowest part of the waist, and its horizontal slide pushed through so as to touch the body. The second slide is then so placed as to bring its curved bar between the legs, close up to the crotch; the third slide opposite, to the most concave part of the outside of the knee, and its shaft pushed through so as to touch the leg at this point. The fourth slide is to stand at that point of the ancle where the pantaloons are to terminate. The distance from the first to the fourth slides gives the whole length of the pantaloons, and the other slides give the variation of the respective parts from the perpendicular, and consequently the curvature to be observed in cutting, with the other information necessary to this process.

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282. For an improvement in the mode of *Supporting the Bodies of eight wheeled Rail Road Cars, and Carriages;* Richard Imlay, city of Philadelphia, Pennsylvania, September 21.

"The nature of my invention consists in placing two cylindrical plates one above the other, in the middle of the carriage, at each end of the car, so that the under one being confined to the body of the carriage, the springs to the upper one, and they connected to the body of the car, there-

by allows of any movement in turning curves, and also a complete rotary motion if desired."

The device above referred to consists of two cast iron wheels, like fifth wheels of a carriage; one of them, which may be two feet in diameter, is fixed firmly on to the centre of the transverse rail of the carriage. It has a stout rim rising vertically at its periphery, the whole being turned perfectly true. A second wheel, also of cast iron, fits into this, and has a bearing upon the lower one, of about four inches in diameter, near the centre. A flanch upon this second wheel covers the rim of the first but does not quite touch it, this being prevented by the centre bearing. The carriage is to rest upon the upper side of the second wheel. To this upper side are also attached three bars of spring steel, parallel to, and at a small distance from each other; these are to be of such length as to be received in pockets, or have their bearings otherwise, upon the side rails of the cars, by which means they become the springs upon which the carriage rests. The claim is to "the vibrating cylinder plates as set forth in the specification, whereby to support all kinds of eight wheeled rail road carriage bodies upon springs."

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283. For an improvement in the *Machine for making Wrought Nails;* N. W. Bishop, and Simon Brooks, Saybrook, Middlesex county, Connecticut, September 21.

The nails are to be fed in between vibrating dies sustained on two horizontal shafts one above the other, toothed gearing causing the shafts to vibrate in unison. One half the die of the upper shaft is capable of a lateral motion, and recedes from the other half, to allow the feeding, but when vibrating back again it is closed and presses the nail laterally, whilst the die on the lower shaft forms it longitudinally. There are also heading dies worked by a toggle joint, and the necessary apparatus for cutting the iron to the proper length. It will be seen that the general principle upon which this and some other wrought nail machines, operate, is the same; the peculiar arrangement only can be claimed.

"We do not claim the making of wrought nails by means of vibrating dies, nor do we claim the use of toggle joints for the opening and closing of dies generally, they having been before used. But what we do claim is the particular arrangement of the toggle joints as herein described, for the opening and closing of the dies, and also for the heading of the nails; this manner of using being, as we verily believe, new, and of our invention."

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284. For an improved method of *Preserving Timber and other vegetable products;* granted to John Knowles, and Robert Gilbert, executors of the estate of Robert Bill, of Great Britain. Auguste Gotthilff, of New York, their Attorney, September 21.

The claim will afford an adequate idea of the nature of this invention, viz:

"What is claimed as new, and as constituting the invention of the before named Robert Bill, is the saturating timber of all kinds with mineral tar or pitch, by covering the same therewith in suitable troughs or tanks, in which it is subjected to the action of heat, in the manner described; which saturation is for the purpose of preserving it from destruction by worms, from dry rot, or from decay from other causes. And also the saturating of

the fibres of hemp and other vegetable substances of which ropes are manufactured, with mineral pitch or tar, as obtained from mineral coal, either alone or in combination with the spirit of coal tar; and in the case of the material for ropes, in combination with turpentine, as herein described, applying the same in all cases at a temperature, and substantially in the manner, set forth, and including under the general denomination of mineral pitch, that species known by the name of asphaltum, or jew's pitch."

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285. For an improvement in the mode of making a *Batting, or Web for Hat Bodies;* Henry A. Wells, James James and Robert W. Peck, city of Brooklyn, New York, September 22.

This patent is taken for improvements on a machine invented and patented by Thomas Blanchard on the 14th of June 1837, and noticed at p. 176 of the last volume. The variations specified are ten in numbers, and the claims are to "the several additions to said machine, as specified, in their combination and connexion therewith."

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286. For an improvement in the composition of matter for *Fire Bricks:* Christopher W. Fenton, Bennington, Vermont, September 22. (See Specification.)

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287. For an improvement in the mode of *Regulating the temperature of Inking Rollers, &c.;* E. W. Arnold, Boston, Massachusetts, September 21.

A hollow metallic drum is to be made of the usual size of inking drums; which drum is to receive the ink from a common distributing roller, like those now used, which take it from the ink fountain underneath; inking rollers of the ordinary construction are to take the ink from this roller and distribute it on the form. One of the gudgeons of the metallic drum is to be hollow, and by means of this opening a pipe is to be introduced through which water may flow into the interior of the drum. This pipe is connected with a reservoir, which may be elevated about a foot above the level of the drum, and is to contain water either warm or cold, according to the temperature desired to be given to the drum. A waste pipe furnished with a stop cock, is also attached, by means of which the water may be drawn off. The claim is to "the heating and cooling, and regulating the temperature of inking rollers and ink, in the operation and process of printing, by the means aforesaid."

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288. For an improvement in the *Endless Chain Horse Power;* Jacob G. Hall, Zanesville, Ohio, September 21.

The improvement claimed consists in the form given to the links by which the slats, forming the revolving floor, are connected together; oval and semi-oval links being employed alternately, the latter embracing the slats of the floor. A claim is likewise made to the manner of constructing the endless chain of rollers, by passing the axles, or round rods on which they revolve, through the rollers and links, without riveting, or other fastening, and retaining them in their places by means of boxes, or troughs, the sides of which prevent their falling out.

289. For an improvement in the *Endless Chain Horse Power;* Aaron Palmer, Akron, Erie county, New York, September 22.

The links which join the slats are made in a peculiar form, having hinge joints, and straps which lap in such a way as to afford considerable sustaining power to the slats. The knuckle of the joint comes under the centre of each slat, a strap extending from joint to joint. In the drawing no other support is represented as being given to the floor upon which the horse is to walk. This will not answer in practice, the whole sustaining power being the joint pins, or the straps.

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290. For an improvement in the *Slide Valves of Steam Engines;* for which a patent was granted to him on the tenth of July 1834; John Kirkpatrick, city of Baltimore, September 22.

This patent is taken for an improvement in the manner of carrying out the original plan of the patentee, by which the valves are intended to work with but little friction.

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291. For an improvement in the mode of *Causing Puppet Valves to work light;* John Kirkpatrick, city of Baltimore, September 25.

The object in view in this improvement is to "cause the unequal action of springs to counteract the unequal action of the puppet valves in opening and shutting. As the valves push much harder when nearly shut, the spring being forced down by the valves in shutting, offer the greatest resistance at that time, and in rising they cease to act as the valves cease to require that action." The claim is to "the application of springs as described, either with or without the piston, to cause puppet valves to work light, using for that purpose any kind of springs best suited to the particular arrangement of the engine to which it is applied."

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292. For improvements in the *Apparatus for Generating Steam in Cooking;* John Bouis, city of Baltimore, September 21.

In the specification of this patent, a long description is given of the mode of conveying steam from a boiler, to perform culinary operations, to heat baths, and for other purposes; but not presenting any thing that is new. The only thing claimed is "the form and construction of the boiler;" which is to be made of boiler iron, "in the form of the false back of a fire place."

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293. For an improvement in the *Galley and Cooking Stove for Vessels, and Domestic uses;* Benjamin Spratley, Portsmouth, Norfolk county, Virginia, September 25.

Like stoves in general, especially those of a complicated character, the claims would not afford any insight into the particular arrangement upon which the claim to novelty is founded.

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294. For an improvement in the *Hydraulic Current Wheel;* Warren P. Wing, Greenwich, Hampshire county, Massachusetts, September 22. (See Specification.)

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295. For an improvement in the *Horizontal Water Wheel;* Chapman Warner, Oxford, Warren county, New Jersey, September 22.

A cistern, in the form of a vertical cylinder, is placed so as to stand on

the sheeting prepared for it at the lower part of a fall of water. This cistern has a hole in its centre through which the water is to escape, after it has acted upon the water wheel, the bottom of the cistern, or cylindrical reservoir, being sufficiently elevated above the sheeting, by means of blocks, for the water to pass out readily. A vertical shaft runs on a step upon the sheeting, in the centre of the opening above mentioned. From this shaft extend out six buckets, or vanes, upon which the water is to operate. These are surrounded by a rim having six openings through which the water is to pass to act upon the vanes, these openings are formed by curved pieces constituting the rim, arranged in the manner of the buckets in Wing's and other reaction wheels. There is a close cover fitted on to these rims, and securely bolted down. From the centre of this cover a tube is elevated through which the shaft of the water wheel passes, the tube rising sufficiently high to prevent the head of water admitted into the cistern from flowing over.

The claim is to "the application of a close chamber, or cistern, in combination with the before described water wheel, in which the water is received and made to strike all the buckets simultaneously, before it passes out at the bottom."

Like the class of wheels, denominated reaction wheels, that just described, will be very wasteful of water; where this is of no importance it may, from its simplicity, be useful; but whether better than the reaction wheels, in any respect, experience must determine; we see no reason, however, why it should be so.

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299. For an improvement in the *Manufacture of Sugar*; John Penny, and William Toland, Parish of Ascension, Louisiana, September 25.

"The object in view is to obtain a complete command of the necessary degrees of temperature, both in heating and cooling the pans, kettles, boilers, or clarifiers employed; which is effected by means of dampers and air flues, the former shutting off the heat at pleasure, and the latter admitting a current of cold air to circulate round the vessels when the heat has been shut off, and it becomes desirable to produce a rapid cooling." After this preliminary remark the specification proceeds to describe the particular manner in which the boilers are set, and the furnace and flues so constructed that by the aid of sliding shutters, or dampers, the heat may be regulated under each individual vessel, or cold air may be admitted in a rapid current whenever its influence is desirable.

The claims made are to "the application of heat, from one furnace, to the evaporating kettles, the granulating pan, and the clarifiers, in the manner set forth; in combination with the means of managing that heat by the aid of dampers, and the introduction of cold air into the space surrounding the clarifiers and crystallizing pan; the whole operating on the principle, and applied to the purpose described.

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300. For an improvement in his Patent *Lamp;* Samuel Rust, city of New York, September 25.

The patentee has made several successive improvements in his lamp, which he has made the subjects of patents. The present claim is to the particular manner in which he inserts a roller for raising the wick into the stopple of his lamp; in a more recent patent, which will be hereafter noticed, another arrangement for raising the wick, still more simple in its character, has been described.

301. For an improvement in the *Mode of Supplying Air to Wood and Coal Stoves;* Frederick Fickhardt, Easton, Northampton county, Pennsylvania, September 25th; patent dated March 25.

The object of the arrangement made in this stove is to supply heated air to the combustible; which heat is to be abstracted from the products of combustion as they escape in the smoke flue. For this purpose different arrangements may be made according to the form of the stove; the following may serve as an example. A smoke flue may surround an oven in the ordinary way; the cold air may be admitted through an opening at the lower end of the back plate of the stove, leading into a flue between the bottom plate of the stove, and the bottom plate of the smoke flues. The cold air thus admitted arrives under the grate bars at the front of the stove, and feeds the fire. In passing from this, around and under the oven, the heated air warms that which is admitted through the back plate. The claim is to the air flue, in the connexions above given.

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302. For a *Parceling Machine;* Obed Kempton, New Bedford, Massachusetts, September 25.

The process of parceling is the spreading of tar upon canvass for the purposes of the rigger; the machine which is the subject of the present patent is for effecting this object in a more expeditious and economical manner than heretofore. The claim will show with sufficient clearness the general construction of the machine.

"What I claim is the making of parceling by passing the canvass, or cloth, over a cylinder, which revolves in a pan or trough containing heated tar, and winding the canvass upon a spindle, the cylinder having a scraper placed at any distance from its surface to scrape off the superfluous tar; and the box or trough being placed upon a furnace or stove, all as above described."

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303. For an improvement in *Many Chambered Fire Arms;* Curtis Parkhurst, Lawrenceville, Tioga county, Pennsylvania, September 25.

In this gun the chamber is a segment of a cylinder, instead of being a complete cylinder, as in Cochran's; the chambers are bored in at the periphery, towards the centre upon which the segment is to revolve; there being a slat, or mortise, to receive it, in the rear of the barrel; the other parts are so arranged as to adapt themselves to the construction of the chambered segment.

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304. For an improvement in the mode of *Setting Axletrees, and in the Machinery therefor;* Timothy Fessenden, Boston, Massachusetts, September 25.

The object in view is to set the axles of carriages so that each shall have the same inclination from a horizontal plane; and consequently, when wheels are dished, to cause them to be equally so.

The apparatus claimed is a species of gauge, to be applied to the axle, after the round or conical ends have been turned, and the two parts welded together. The axle may be laid on a bench, and the gauge applied. This gauge consists of a straight bar of sufficient length, and it has on it three sliding pieces, capable of adjustment, which project at right angles from it. The extreme ends of two of these slides are to be so adjusted as to come into contact with one of the journals of the axle, one of them near its end, and the other near its shoulder; the third gauge piece, at the opposite end of

the long bar, being placed in contact with the opposite journal, near its shoulders. If these three points are in contact, and on being reversed are still in contact, the journals are true with each other; if not they require setting. The claim is to the mode of setting the axles, and to the apparatus as described.

Had we been engaged in the business of setting axles, we certainly should have resorted to some mode substantially the same with the foregoing, and should have done this without being sensible that we had made any invention or discovery.

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305. For an improvement in *Stoves*; Thomas Mills, Havanna, Chemung county, New York, September 25.

This is a species of box stove, for heating. The bottom, if bottom it can be called, consists of two plates, each reaching from near the lower edges of the side plates to the middle of the top plates, leaving an open space from front to rear of the stove, in the form of a common tent. There are ribs on the interior of the plates for the fuel to rest against. The fire chamber consists of two compartments, both of which are to be supplied with wood. The claim is to the making two chambers of combustion, by the arrangement of the plates as described; also to the projections on the insides of the plates, and double sunk hearths, in the manner in which they are combined.

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306. For improvements in the *Water Wheel, and the Mode of letting Water on the same;* Samuel Curtis, Eagle, Alleghany county, New York, September 28.

Perceiving nothing in this wheel to recommend it, as superior to others, and believing that instead of being so, it will disappoint the hopes of its projector, we shall give only the claim.

"The invention claimed by me consists in the manner of introducing the water inside the wheel, and causing it to act by percussion as well as reaction, as above described; and the mode of forming and adapting the buckets thereto."

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307. For an improvement in the *Mortise Latch for fastening Doors;* Charles S. Gay, Nashua, Hillsborough county, New Hampshire.

In this instrument a spring latch is protruded, and drawn back, by a knobbed handle in the ordinary way. The novelty consists in what is called a rotary guard, which is to be turned by means of a key, and which catches upon the bolt so as to prevent its being withdrawn until the guard is turned back again, thus making it answer the purpose of a lock. The claim is to this rotary guard. The latch deposited in the patent office is a good one, being well made, and not liable therefore to get out of order. As to the rotary guard, it will certainly answer the purpose intended perfectly well; few things, however, would be more easy than to devise a dozen modes equally good.

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308. For an improvement in the *Mortise Latch for Fastening Doors;* David N. Ropes, Portland, Maine, September 28.

This latch is a spring lifting latch, operating in the manner of the lifting latches which are used in the modern imported English patent door locks. It is made in a very simple manner, which is its only merit. The latch

part is made of iron, and upon the top part of this a narrow strip of steel is riveted which extends out behind it, and is firmly fastened to the box or plate of the latch. This spring forces the latch down, and it is raised by a lifter on a knobbed handle, in the usual way.

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309. For *Drafting out the fore part of Coats;* Allen Ward, city of Philadelphia, September 28.

We are informed by the patentee that "the following draft, or diagram of a coat will show the practical tailor how to produce the balancing points of coats according to the new method, with about half the labour usually bestowed for that purpose." Those interested in the invention or discovery may obtain the said drafts at the patent office. Were there any probability that this great improvement would lessen the charge to the consumer of coats, we would take some trouble to make it known, as this would be a balancing point of general interest; of this, however, we have no hope, but, on the contrary, apprehend a charge for the patent right.

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310. For an improvement in the *Machine for Cutting Leather;* Levi N. Leland, Grafton, Massachusetts, September 28.

This is a machine intended principally for cutting out the soles of boots and shoes. The leather is first to be cut into strips of a proper width; that is, equal to the length of the sole to be cut. A sliding frame, acted upon by a rack and toothed wheel, is placed upon a frame within the cheeks of which it slides horizontally. Knives of a proper curvature cross this frame from side to side, being held in grooves prepared to receive them. The edges of these knives are upwards, and are all on the same horizontal plane. A cylinder, which may be turned by any adequate power, crosses the machine above the edges of the knives, and has toothed wheels on each of its ends which take into the racks upon the knife frame. The cylinder is adjustable, and its periphery bears upon the edges of the knives. When the leather is passed between them, it will be cut, as desired, and will fall through between the knives.

The claim is to "the cylinder in connexion with the carriage under it, the slide placed in the carriage, and the knives inserted in the slide, and the mode of regulating them, as set forth."

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311. For an improvement in the *Endless Chain Horse Power;* Henry G. Hall, Putnam, Muskingham county, Ohio, September 28.

The difference between endless chain horse powers, for which patents are claimed, is frequently as small as that existing between cylinder thrashing machines. Care, of course, is taken in the office to confine the claims, in these cases, to those things which appear to be actually new, and, however small such a thing may be, if it have the character of novelty, and appears to be substantially different from what has preceded it, no more can be required; its importance is a question between the patentee and the public. The claim in the present instance is to an "additional link for strengthening the chain," so as more securely to bear the weight of the horse.

Specifications of American Patents.

Specification of a patent for a composition of matter for the manufacture of Fire Bricks; granted to Christopher W. Fenton, *Bennington, Vermont, September 22nd,* 1837.

The nature of my invention, or discovery, consists in mixing, in the manufacture of fire bricks, the following substances, to wit: the earth usually denominated kaolin, or porcelain clay, and fine granular quartz, or white sand, or sandstone, frequently, if not commonly, used in the manufacture of glass; which bricks, when shaped, and sufficiently dried, are baked in a high heat.

To enable others skilled in the art to make and use my invention, I will now describe the manner in which I proceed. I compose the said fire bricks of the said kaolin or porcelain clay, and fine granular quartz, being a species of pure white sand, or sandstone, as before mentioned, in equal parts, or in any other available proportion, though I prefer equal parts, or nearly so. These two substances being intimately mixed together and moistened with water, so as to bring the whole to a proper consistency, I then shape the mass into bricks, or other blocks, by the aid of moulds, after the common manner of making bricks. When these bricks are sufficiently dried I bake them in a high heat; they are then fit for use, and will resist a greater degree of heat than any other substance or composition of matter known to the inventor as applicable to this purpose.

What I claim as constituting my invention and discovery, and wish to secure by letters patent, is the using and applying the aforesaid substances, known under the name of kaolin, or porcelain clay, and granular quartz, being a species of white sand, or sandstone, frequently used in the manufacture of glass, in the manufacturing of fire bricks; which fire bricks are capable of resisting an intense heat; and I claim the composing said fire bricks of these substances in any proportion, be it in equal or unequal parts.

Christopher W. Fenton.

Remarks by the Editor. The testimonials respecting the goodness of the bricks made by the patentee are satisfactory upon that point, as they have been well tested, and compared with others, in iron furnaces. The term kaolin, or porcelain earth, is not a very distinctive one. The substance so called by us, is not identical with the true kaolin of China; and it will be found to differ in the proportion of its constituents in different localities; that used by the patentee offers no assurance therefore, that the material known by the same name in another place, will possess like refractory properties.

Specification of a patent for an improved current water wheel; granted to Warren P. Wing, *Greenwich, Hampshire county, Massachusetts, September 22nd,* 1837.

To all whom it may concern, be it known, that I, Warren P. Wing, of Greenwich, in the county of Hampshire, and State of Massachusetts, have invented certain improvements in the hydraulic current wheel, by means of which the flowing of a current, or tide, may be more efficiently applied than it has been heretofore to the raising of water,

or to other purposes for which power is required; and I do hereby declare that the following is a full and exact description thereof.

For the sake of facility of description I will give the form and dimensions of one which I have put into operation, and which has been found to answer well in practice. The wheel consists of a shaft upon which are placed flights, or buckets, against which the water is to strike and give motion to the shaft, the flights being placed obliquely thereon. The shaft of this wheel, is thirty feet long, and eight inches in diameter; its form is octagonal. Into four of the sides I insert seven flights or buckets, making twenty eight in the whole. At one end of the shaft the flights are twenty inches long, and at the other end forty, the intermediate flights increasing equally in length from the shortest to the longest. They are each about eight inches wide near the shaft, and spread out in a fan-like form, so that their extremities occupy about one eighth of the circle, or circumference, of the wheel. The flights or buckets are flat on the face and they are set so as to form an angle with the axis of the shaft, usually of about thirty degrees; but this angle will vary according to the velocity of the current, and accordingly as the shaft varies more or less from the line of direction of the current: a distinguishing characteristic of my wheel being the placing of the shaft so as to form an angle with the direction of the stream both vertically and horizontally. The buckets, or flights, may be of iron, or other material. The wheel is to be placed so far below the surface as to be out of the way of floating ice, &c.

The shaft, as above intimated, is to be placed obliquely to the direction of the current. In a wheel of the size mentioned it may vary about six feet from the direct line, both horizontally and vertically, by which means the force of the water upon the flights will be greatly increased. Two or more such shafts may be coupled together, and to prevent inconvenience from their great depth in the water, the angles of the shafts with the current may be reversed, so that whatever their number their depths below the surface will remain the same. From the gudgeons of the shafts the power may be communicated in any convenient way.

I do not claim as new the employment of wheels consisting of a shaft furnished with flights, or buckets, these having been used; but what I do claim is the increase of the length of the flights so as to give to the outside of the wheel the form of the frustrum of a cone; and also the placing of such shafts in the current so as to form a decided angle therewith, in the manner described.

WARREN P. WING.

Specification of a Patent for a process for protecting articles made of Iron or Steel from oxidation. Granted to M. SOREL, *of the city of Paris, in the Kingdom of France. December,* 1837.

To all whom it may concern; be it known, that I, M. SOREL, of the city of Paris, in the Kingdom of France, have invented, or discovered, a process, method, or methods, by which various articles made of iron or steel, may be effectually preserved from oxidation, or rusting, by the galvanic action produced by zinc, and I do hereby declare that the following is a ull and exact description thereof.

It is well known to chemists and to all persons versed in the physical sciences, that a galvanic action is produced by the contact of two metals different in their natures, and that the most oxydable of the two metals so brought into contact becomes positively electrified; whilst that which is least oxydable becomes negatively electrified, and also that, when brought into this state, the most oxydable, or positively electrified metal, has a tendency to become oxidized, and will abstract oxygen from compounds containing this agent; whilst the least oxydable of the two metals will be protected from oxidation, although exposed to agents which would oxidize it, but for the contact of the negative metal. My process depends, for its efficiency in protecting iron and steel from oxidizing, or rusting, upon the manner in which I apply this principle.

The process of covering articles of iron with tin is well known, and is exemplified, most largely, in the manufactory of what is usually known under the name of sheet tin, or tin plate, which consists of thin sheets of iron coated with tin. In this material there is necessarily galvanic action between the two metals, but it is to the disadvantage of that which it is proposed to protect, namely, the iron, which being more oxydable than tin, becomes positively electrified, and has its tendency to rust increased; the protecting effect of the tin depending in this case entirely upon the perfectness with which the iron is coated by it; as is clearly evinced by the rusting of the iron whenever any portion of this coating is removed, and the iron is exposed to the action of air and moisture. Were the galvanic action in favour of the iron, it would be protected notwithstanding the abrasion of the tin, as its protecting influence is not limited to the mere point of contact, but extends far beyond it.

In the scale of the oxidability of the different metals, commencing with those which are the most oxidable, it has been found that zinc stands before iron, and it follows, therefore, that when these two metals are brought into contact, a protecting influence will be exerted upon the iron by the zinc, and that the rusting of the former metal will be thereby prevented.

It might be supposed, from the fact that zinc is more oxidable than iron, that this metal, if employed to protect iron, would itself soon become oxidized, or rusted, and would, consequently, leave the iron unprotected; and such reasoning would undoubtedly be just, but for another fact, well known to chemists, that there are certain metals, of which zinc is one, which after they have acquired a thin superficial coat of oxide, are thereby effectually protected from the further absorption of oxygen, under ordinary exposure.

Having thus fully exemplified the principle upon the application of which my process is dependent for its efficacy, I will now proceed to give the necessary details, and the various modes which I have devised, for carrying the same into operation. These modes which I have essayed, are five in number, and are as follows:

First, applying the zinc to the iron or steel in the manner in which tin is applied in the process of tinning.

Second, applying a galvanic powder in the manner of paint, which consists in mixing the zinc, reduced to fine powder, with oils, or resinous materials, so as to form a paint or varnish, with which the substances to be protected are to be covered, in the ordinary manner of painting, or varnishing.

Third, covering the articles to be protected, with the galvanic powder, consisting of zinc finely comminuted.

Fourth, wrapping the articles to be protected in what I denominate galvanic paper.

Fifth. Anointing or covering the articles with a galvanic paste, consisting of any suitable fatty matters, such as purified lard, in which the galvanic powder has been freely mixed.

The first process, that of coating the articles to be protected with metallic zinc, is to be effected much in the same manner in which tinning is performed, that is to say, the articles to be coated must be rendered clean, and free from oxide, by processes analogous to those followed in preparing them for ordinary tinning; such as immersing them in diluted sulphuric or muriatic acids, scouring them, and so forth; which processes being well known, need not to be described. The zinc, in like manner, must be fused in proper crucibles, or other convenient vessels, adapted to the nature and size of the articles to be operated upon; special care being taken to keep the metal covered with sal ammoniac, or other proper flux; and to regulate the heat in such way as is required by the volatile nature of the metal. The articles to be coated, after being dipped into the melted zinc, are to be withdrawn slowly, that too much of the metal may not adhere to them. They are then to be thrown into cold water, rubbed with a sponge, or brush, and dried as quickly as possible, as otherwise they may be injured by the appearance of dark spots, which it is desirable to avoid.

When chains for cables, or for other purposes, are being withdrawn from the zinc, they must be shaken until sufficiently cooled to prevent the links from being soldered together by the melted metal. The coating of small chains requires careful management, but by the following procedure it is effected without difficulty. Whilst in the dilute acid, they are to be moved about to expose all their parts equally to its action, they are then to be dipped into muriatic acid, and immediately dried in a reverberatory furnace. The melted zinc being ready, and covered with sal ammoniac, the chains are to be put into it, and suffered to remain there about a minute; they are next slowly taken out by means of an iron skimmer, or other convenient instrument, which will allow as much of the zinc to drop from them as can be got rid of in that way; the links, however, will still retain too much zinc, and will be soldered together. To correct this they are to be put into a reverberatory furnace, to be covered with charcoal, and retained at a red heat for about a quarter of an hour, during which time they are to be moved about by means of an iron poker; by this treatment the excess of zinc will be discharged; they are then to be drawn towards the mouth of the furnace where they are kept in motion until the zinc is solidified. When small nails, and such like articles, are to be coated, the process should be performed in small crucibles, this being necessary to prevent the danger of spoiling a considerable portion of zinc, which results when iron has been kept in it for a considerable length of time, as it is thus rendered unfit for the purpose of a protective coating. In all cases the purest zinc should be employed. Wire may be coated by passing it through the melted zinc, as it is wound of from one drum or reel, on to another.

When articles of iron have been coated with zinc, it is sometimes desirable to cover this coating with one of tin; more especially when culi-

nary vessels are the subjects of the operation. It may also be resorted to when it is desired to give a brighter and more handsome surface than the zinc affords; such a coating of tin will not destroy the galvanic effect of the zinc; and it is to be effected in the ordinary way of tinning, particular care being taken not to heat the tin too highly, or to keep the articles in it so long as to remove any portion of the coating of zinc.

The galvanic powder, consisting of zinc reduced to that state, may be obtained by various means; the following, however, I have found to be the most economical of any which I have essayed.

The zinc is put into a reverberatory furnace, and brought nearly to a red heat, care being taken to prevent the access of a current of air; it is then carefully skimmed, and covered with sal ammoniac.

Iron filings, equal in weight to about one tenth part of the zinc, are to be moistened with muriatic acid, and thrown on the fused zinc; the whole is to be covered with finely pulverized charcoal, and the heat of the fused metal raised to whiteness, and so retained for a quarter of an hour, agitating it at intervals by means of an iron poker. The melted mass is then to be run off into a brick or cast iron reservoir, which is covered with a plate of cast iron, to prevent the combustion of the zinc. Through an aperture on the cover, a poker, or stirrer is to be introduced to agitate the alloy, which is to be done until it is cool, when it will be in fine powder.

The galvanic paint is prepared by grinding this powder with the fluid which is to be employed to form it into a paint, or varnish. Various fluids may be used for this purpose. I have sometimes employed the oil distilled from coal tar. Coal tar itself answers well, with the addition of one third of spirits of turpentine, or of a sufficient quantity to bring it to a proper consistence. For purposes where the odour of this mixture would be objectionable others may be substituted.

Articles of polished steel, or iron, packed in this galvanic powder, so as to be covered thereby, will be preserved from oxidation, even should they become moistened from any accidental cause.

Galvanic paper may be prepared either by the mixing of the powder with the pulp in the manufacturing of the article, or by taking the ordinary wrapping paper, coating it with any suitable adhesive substance, and sifting the galvanic powder over it. Polished, or other, articles, wrapped in such paper, will be effectually protected from rust by the galvanic action.

The preparation of the galvanic paste has been sufficiently explained, and its operation in protecting the articles coated with it will be readily understood, as it is analogous in this respect, to those previously described.

Having thus fully explained the principle upon which my process of protecting iron and steel from rusting, or oxidating, is dependant; and having also given the various modes in which I have contemplated the carrying the same into effect, I do hereby declare that what I claim as of my invention, and wish to secure by letters patent, is the employment of zinc, in various forms, as a covering to the respective articles to be thereby protected, as herein set forth. I do not claim to be the discoverer of the principle of the protection of metals from oxidation by galvanic action; nor do I claim to be the first to have proposed the employment of zinc for the preserving of iron therefrom; masses of zinc having been

applied, or it having been proposed to apply it in masses, to steam engine boilers, and probably to other articles, with this intention; but from this, my plan, or mode of procedure, differs as obviously as it surpasses it in efficiency, and in its applicability to numerous purposes in the arts where the application in masses would be impossible, or altogether unavailable.

SOREL.

Progress of Practical and Theoretical Mechanics and Chemistry.

Templemoyle Agricultural School.

Any one who duly reflects upon the infinite importance of giving to the youth of our country, an education wisely adapted to their prospects in life, —to the peculiar character of an American citizen,—to the nature of our Institutions,—to our social polity and republican habits,—must, we think, regret the failure of the bill so favorably introduced into the Legislature, and so ably supported, of establishing a School of Arts under the supervisions and management of the Franklin Institute. It might be difficult to add much to the arguments so forcibly urged by the principal advocates of the bill; and we cannot but believe, that extended observation and maturity of reflection will eventually satisfy every parent and guardian that he could make no better provision for the prosperity of a son or a ward, destined to fill an active and productive sphere of life, than to place him in a school where, in addition to the requisite amount of literary instruction, he may acquire a knowledge of those practical sciences, to which his time and energies must necessarily be devoted. Such a school as that whose outlines and objects were presented to the Legislature, would furnish incalculable advantages to those who have in prospect an engagement in any of the arts, trades and manufactories which are becoming so immensely important to the wealth of our country. To those whose views are more exclusively agricultural, such establishments as the one described in the subjoined article would be worthy of all imitation.

G.

To the Editors of the Irish Farmer's and Gardener's Magazine.

GENTLEMEN—You will render a service to Ireland, and advance the interests of that branch of her industry (agriculture) whence she derives her principal resources, by giving a place in your widely circulated pages to the following account of an establishment now in operation for ten years, the extension of which, and the formation of similar schools elsewhere, are the sole rewards aimed at by the noblemen and gentlemen who were the founders of it, of whom many are still zealous, as the committee of management, in promoting its success.

I have the honor to remain, Gentlemen, Your obd't humble serv't,

ONE OF THE COMMITTEE.

The Agricultural Seminary of Templemoyle originated at a very numerous meeting of the Northwest of Ireland Farming Society at Londonderry, and it was at first intended that it should consist of two establishments, taking Mons. Fellenberg's Institution at Hoffwyll in Switzerland in some degree as the model: the first to be a school affording instruction in every science and accomplishment aimed at by the children of the higher orders; the second for the education of the sons of respectable farmers and tradesmen, in the hope of disseminating the advantages of an improved system of

farming with greater certainty, by combining the practice and theory of it in the instruction of those who were afterwards to make agriculture their pursuit. It was hoped that the extended scale of the institution would have allowed of a greater variety of masters and lecturers, and that the profit derived from the superior school would have contributed towards the maintenance of the secondary one; but a short experience convinced the subscribers that such a scheme was impracticable without much larger and more certain funds than they could rely on; they then gave their undivided attention to the agricultural seminary, which through their increasing exertion has attained such eminence as may justly entitle them to look forward with confidence to its increasing usefulness, and to its becoming a model for establishments of a similar nature in other parts of Ireland.

The school and farm of Templemoyle are situated about six miles from Londonderry; about a mile distant from the mail-coach road leading from Londonderry to Newtowlimavady. The house, placed on an eminence, commands an extensive and beautiful view over a rich and highly cultivated country, terminated by Lough Foyle. The base of the hill is occupied by a kitchen and ornamental garden, cultivated by the youths of the establishment, under an experienced gardener. The ground between the garden and house is laid out in beds in which all the different grasses, clovers, &c., are cultivated with the greatest care. The house is in the form of an ||=||, with ranges of farming offices behind, containing spacious, lofty, and well ventilated school-rooms; refectory, dormitories, apartments for the masters, matrons, servants, &c.

Each pupil occupies a separate bed; the house can accommodate seventy-six, and the number of pupils amounts to sixty. They receive an excellent education in reading, writing, and arithmetic; book-keeping, mathematics, land-surveying, and geography. This department is managed by an excellent head master and assistant master, both resident in the house. The pupils are so classed that one-half are receiving their education in the house, while the remainder are engaged in the cultivation of a farm of 130 Cunningham or 165 statute acres, in the management of which they are directed by the head farmer, an experienced and clever man, a native of Scotland, who has a skilful ploughman under him. The pupils who are employed one part of the day on the farm, are replaced by those in the school, so that the education always advances in and out of doors *pari passu*.

The pupils are thus instructed in all the practical parts of farming, and are also lectured several times a week on the theory of agriculture. They are made acquainted with all the properties of different soils, the manures most applicable, and the crops best adapted to each; points in which most of our practical farmers display great ignorance. They are also made acquainted with all the numerous varieties of cattle, and their qualities, such as early maturity in some breeds, hardihood in others, and have strongly impressed on them that one of the most essential points in farming, is to select the cattle and the crops best adapted to the situation, soil, &c.

The stables, harness-rooms, cow-houses, winter-feeding houses, piggeries, barn, tool-houses, are arranged in the best manner, and the pupils are required to keep them and their contents in the highest order. A respectable and intelligent matron has the superintendance of the dairy, cooking, and cleaning the house, and the charge of the domestic servants.

The formation of this establishment has caused its founders an expenditure of above four thousand pounds; of which about three thousand were raised at its commencement by shares of £25 each, by the noblemen,

gentlemen, and members of the North-west Society. The Grocers' Company, on whose estate it is situated, have been most liberal in their assistance, and have earned a just reward in the improvement of their property, by the valuable example the farm of Templemoyle presents to their tenantry; and it is gratifying to state, that the example is not confined to so limited a circle, but is followed, to a very great extent, by the farmers to a considerable distance.

In sending a pupil to Templemoyle it is necessary to have a nomination from one of the shareholders, or from a subscriber of £2 annually. The annual payment for pupils is £10 a year; and for this trifling sum they are found in board, lodging, and washing, and are educated so as to fit them for land-stewards, directing agents, practical farmers, or surveyors, schoolmasters, or clerks.

From fifteen to seventeen is the age best suited for entrance at Templemoyle, as three years are quite sufficient to qualify a student possessed of ordinary talents and a knowledge of the rudiments of reading and writing, to occupy any of the above situations. If this very short and imperfect sketch of what must and will become a more generally useful institution, as it is more known and appreciated, should lead the reader to wish any fuller information, he may easily be gratified by visiting the agricultural seminary, or by applying to the zealous secretary to the committee, Pitt Shipton, Esq., Londonderry, under cover to Sir R. A. Ferguson, Bart., M.P., who will furnish printed reports containing the history of the rise and progress, the names of the shareholders, the rules and regulations of the society, hours of school and labour, dietary, and a variety of minutiæ, which, though extremely valuable and necessary to be known, yet from their length might prevent the insertion of this outline of the Templemoyle Seminary in those works which, from their circulation, may both increase the utility of the publication, and the knowledge of an institution of which the advantages have been felt and appreciated in the north of Ireland.

N.B.—Upwards of two hundred young men, natives of sixteen different counties in Ireland have passed through, or remain in, the school. Of these between forty and fifty have been placed in different situations, such as land-stewards, agents, school-masters, and clerks, or employed on the ordnance survey. Nearly one hundred are now conducting their own or their father's farms in a manner very superior to that of olden time; and the accounts of those who have been placed from the seminary are such as to gratify the gentlemen who have its interest at heart, and to convince them that the good seed sown is producing an ample and valuable harvest.

Templemoyle, Oct. 14, 1837.

[It gives us unqualified pleasure to lay before our readers the above gratifying account of an institution so eminently calculated to confer lasting benefits upon the country. We have been long strenuous advocates for the establishment of agricultural schools in all parts of Ireland, feeling assured that they would ultimately be the means of breaking down those absurd prejudices which have been hitherto the most insurmountable obstacles with which agricultural improvement had to contend.]—*Editors.*

Farmers' Magazine.

Statistical Tables of the Manufacturing Industry of Massachusetts.

The result of an inquiry into the actual number and amount of the various products of Industry within the state, has been returned by the assessors, in conformity to a law which enjoined this duty upon them. The

facts are returned as they existed on the first day of April, 1837, and have been arranged and published by JOHN P. BIGELOW, secretary of the Commonwealth. The report makes an interesting volume of 212 pages, 8vo. A condensed summary, as we find it at the close of the volume, we think will furnish acceptable information to most of our readers.

Articles manufactured or produced.	Value.	Hands employed.	Capital invested.
Anchors, Chain Cables, &c.,	$ 114,125	36	$ 80,500
Axes, Scythes, Snaiths, &c.,	325,956	387	196,938
Beer, Bellows, Blacking, Boats and Wherries, Bricks,	152,321	273	55,300
Bonnets, (Straw) and Palm-leaf Hats,	1,902,803		
Books and Stationary, Pocket Books, and School apparatus,	1,048,140	1023	909,800
Boots and Shoes,	14,642,520	39.068	
Brass and Copper,	1,469,354	297	635,800
Britannia and Block Tin,	66,300	59	7000
Brushes, Brooms, and Baskets,	289,512	350	103,095
Buttons, of all kinds,	246,000	358	147,200
Candles, (Spermaceti and Tallow,) and soap,	1,620,730	266	697,300
Candlesticks, Playing Cards, Chocolate, Clocks, Chair Stuff, and Coffee Mills,	66.914	81	29,840
Cards, (Wool,)	254,420	139	148,340
Carriages, Wagons, Sleighs, Harness, &c.,	679,442	945	278,790
Casks and Hoops,	202,832	194	81,250
Chairs and Cabinet Ware,	1,262,121	2011	
Clothing, Neck Stocks, and Suspenders,	2,013,316	3939	780,158
Combs,	268,500	444	
Cordage and Twine,	481,441	439	285,375
Cotton Goods, (Cloths,)	13,056,659	19,754	14,369,719
Cotton Batting, Thread, Warp and Wicking,	169,221	151	78,000
Cotton Printing,	4,183,121	1660	1,539,000
Cutlery,	186,200	193	92,033
Drugs, Medicine, and Dye Stuffs,	371,019	97	98,995
Fishery, (Whale, Cod, and Mackerel,)	7,592,290	20,126	12,484,078
Fur Caps, and other manufactures of Fur,	73,000	100	55,000
Gas,	100,000	40	375,000
Glass,	831,076	647	759,400
Glue,	34,625	18	19,700
Gold and Silver Leaf,	43,000	36	11,200
Gunpowder,	246,357	77	160,800
Hats,	698,086	867	
India Rubber,	18,000	13	10,000

Articles manufactured or produced.	Value.	Hands employed	Capital invested.
Iron Castings, Bar and Rod, &c.,	1,658,670	1311	1,516,025
Jewellery, Silver, and Silver Plate,	325,500	207	161,550
Lead Manufactures,	201,400	43	6400
Leather, including Morocco,	3,254,416	1798	2,033,423
Looking Glasses,	165,500	58	61,600
Lumber, Shingles and Staves,	167,778	121	27,750
Machinery, of various kinds,	1,235,390	1399	1,146,775
Muskets, Rifles, Pistols, Swords, &c.,	288,800	394	65,943
Nails, Brads, and Tacks,	2,527,095	1095	1,974,000
Oil, (Refined Whale and other Oil,)	2,030,321	145	1,133,500
Organs and Piano Fortes,	324,200	239	172,000
Paper,	1,544,230	1173	1,167,700
Ploughs,	54,561	73	
Saddles, Trunks, and Whips,	351,575	758	109,825
Salt,	246,059	708	801,753
Shovels, Spades, Forks and Hoes,	264,709	284	225,523
Silk,	56,150	125	137,000
Spectacles, Starch, Stone and Earthen Ware,	35,560	47	20,974
Spirits,	1,238,789		
Stone, (Granite, Marble, Slate and Soap Stone,)	680,782	1177	209,950
Stoves and Stove Pipe,	31,000	13	11,815
Sugar, (Refined,)	976,454	92	303,653
Snuff and Segars,	184,601	396	33,300
Tin Ware,	394,322	377	
Tools, (Carpenters', Joiners' and Shoemakers',)	258,531	279	110,807
Types and Stereotypes,	157,000	215	140,000
Umbrellas,	104,500	136	56,500
Upholstery, including Bed-binding, Curtains, Hair and Paper Hangings,	55,483	86	13,160
Vessels built in the five years preceding 1st April, 1837,	6,853,248	2834	
Varnish and Beeswax,	52,600	8	9000
Window Blinds, Sashes, and Doors	74,166	93	8350
Wire,	84,770	53	44,200
Wooden Ware, including Packing Boxes, Rakes, Shoe Pegs, Yokes and Helves,	174,692	313	26,950
Wool,	539,689		2,842,778
Woollen Goods,	10,399,807	7097	5,770,750
Engravings, Essences, Hosiery, Lamp-black, Mathematical Instruments, Mustard, Razor Straps, Lather Boxes, Pumps, Blocks, &c. &c.,	63,466	117	19,078
Total,	$91,765,215	117,352	$54,851,643

The preceding presents the grand total of the returns of the Assessors. It will be perceived that it includes vessels built in the *five* preceding years; all the other articles named having been manufactured or produced within *one* year preceding April last. Deducting the vessels from the above statement, and allowing one-fifth of the value set against them as the proper average for a *single* year, there will remain the sum of *eighty-six millions, two hundred and eighty-two thousand, six hundred and sixteen dollars*, as the value of the articles manufactured or produced by the several specified branches of industry, carried on by the citizens of this State, during the year ending April 1, 1837.

The population of the State, agreeably to the official returns, was on the first day of May 1837, 701, 331. That, of each of the 13 largest towns, was as follows: Boston, 80,325; Lowell, 18,010; Salem, 14,985; New Bedford, 14,304; Charlestown, 10,101; Lynn, 9,323; Springfield, 9,234; Taunton, 7,647; Roxbury, 7,493; Worcester, 7,117; Gloucester, 8,822; Cambridge, 7,631. The population of Nantucket was 9,048.

Taking the superficial extent of Massachusetts at 7250 square miles, (for we find it variously stated in geographical books) it appears that the population is verging very closely upon 100 to a square mile, which is allowing nevertheless nearly $6\frac{1}{2}$ acres to each individual. The whole number of sheep in the State was 374,614; the average weight of whose fleeces was $2\frac{7}{8}$ lbs. per head. Each labourer, as is evident from the table, produces an amount of manufactured goods, worth more than 700 dollars, and the whole amount is nearly double that of the capital invested. Such statistical returns from each of the States, furnished at intervals of five years, would afford highly interesting data, and if consigned, as in this case, to the care of assessors, the information might be obtained in the most correct, cheap and effectual manner. G.

On a new Property of the Iodide of Silver. *By* H. F. Talbot, Esq., F.R.S.

It is well known that certain metallic oxides and salts have the property of changing their colour when heated, and recovering it again when cold. The iodide of silver affords an extremely remarkable instance of this, and yet, I believe, the fact is not mentioned by any chemical author. I have no doubt, therefore, that a short notice of it may possess some interest.

Let a sheet of white paper be washed over with a solution of nitrate of silver, and afterwards with a *rather dilute* solution of hydriodate of potash. it will immediately assume a pale yellow tint, owing to the formation of Iodide of silver. The paper may then be dried and laid aside for use.

When the property in question is to be exhibited, the paper is held for some moments before a hot fire, and its colour changes from a pale primrose tint, to a rich gaudy yellow, emulating the sunflower.

Removed from the fire, this bright colour gradually fades away, and in three or four seconds it is entirely gone. It may then be reproduced, and again destroyed as before, and so on for any number of times, for the heat causes no alteration in the substance experimented upon.

When the paper is warm and very yellow, if the finger is pressed upon it and quickly removed, it leaves a print, or impression, of its shape, which is nearly white. The cause of this is, that the finger is a much better conductor of caloric than the atmospheric air, and therefore cools the paper in an instant of time. Any cold substance may be substituted for the finger,

and the effect can be produced at a little distance, without actually touching the paper, merely by the radiation of the cold body. It appears therefore, that this substance, from the peculiar suddenness with which it changes colour, is well adapted for experiments on the radiation and conduction of heat.

If now we throw some drops of ammonia on the paper, it turns white, and if we hold it to the fire we find that it has lost the power of changing colour. Gradually however the ammonia evaporates, and then the alternations of colour occur as before. This seems to prove that the alkali enters into chemical combination with the iodide, and possibly the white substance is the double iodide of silver and ammonia. This opinion is confirmed by observing that potash and soda act in a similar manner, giving rise to *permanent* white compounds unchangeable by heat, which are probably the double iodides of silver and potassium, and silver and sodium.

This is the reason why the paper was directed to be washed with a *rather dilute* solution of hydriodate of potash; for if we use a concentrated solution the resulting tint is white, and the colour of the paper is not changeable by heat.

I have kept some pieces of this prepared paper for a year or two, and find that it still remains as sensitive to heat as ever.

Lond. & Edin. Philos. Mag.

Dr. Lardner's Steam Engine Indicator.

At the last annual meeting of the British Scientific Association, held at Liverpool, a grant of money was placed at the disposal of a committee, to investigate the actual performance of steam vessels with reference to their speed, consumption of fuel, and other circumstances affecting their general efficiency. This investigation arose from a discussion which took place in the mechanical section, in the course of which statements the most conflicting were made, even by practical men, as to the capabilities of steam vessels for extended navigation. In prosecuting their inquiry, the committee have thought it desirable to adopt some method of registering the actual performance of the vessel in a log, which will not be subject to the errors and neglect which have hitherto rendered all steam-logs more or less useless.

With this view Dr. Lardner has attempted to construct a piece of mechanism, which will enable the steam-engine itself to write the journal of its own proceedings. This mechanism is now being constructed, and is intended to be placed in the "Tagus," a large and powerful steam-ship belonging to the Peninsula Steam Navigation Company,—this Company having liberally offered to co-operate with the committee.

The circumstances on which the efficiency of the machinery and the vessel principally depends, and which it is necessary to register, are the following:—

1. The height of the barometer-gauge, which indicates the state of the vacuum produced by the condenser.

2. The height of the steam-gauge which indicates the actual pressure of steam urging the piston.

3. The height of the steam-gauge which indicates the actual pressure of steam in the boiler.

4. The number of revolutions of the paddle-wheels per minute.
5. The depth of water in the boiler.
6. The degree of saltness of the water in the boiler.
7. The rate of the vessel.
8. The draught of the vessel, or her immersion.
9. The direction and force of the wind.
10. The course of the vessel.

The mechanism now being constructed will keep a self-recording register of the first six of these. A provision is, however, made for subsequently adding means of registering the seventh and eighth, should it be found desirable to do so. The consumption of fuel will be easily determined by keeping an account of the quantity of coals delivered into the vessel at each port, making an allowance for what is consumed in the steward's room, kitchen and cabins.

A float is placed on the mercury in the barometer-gauge, from which a rod proceeds, to which the pencil is attached. As the column of mercury rises or falls the pencil receives a corresponding motion, and being pressed against the paper on the cylinder leaves a trace upon it, which measures the extent of the variations of the mercurial column.

The heights of the steam and other gauges are registered in the same manner by other pencils.

The entire apparatus will be enclosed in an octagonal case, about three feet and a half high, and three feet diameter. It will be locked by the agents of the owners when the vessel starts on her voyage, and will not be opened till her return. It will require no other attendance during the voyage than that of winding the clock.

The several pencils will be of different colours, so that their traces may be easily distinguished one from the other. Besides which it will be so arranged that their play may be confined to different parts of the cylinder.

At the end of each voyage the paper will be removed from the cylinder, and replaced by a clean sheet.

If it be thought advisable, the indications of the several curves traced by the pencils may afterwards be translated into the ordinary language of log-books.

It is not improbable that an anemoscope and other apparatus may be contrived, by which the direction of the wind and the course of the vessel may likewise be recorded, at least with as much precision as they are now ascertained by other and less regular expedients.

If this mechanism should succeed in attaining the objects for which it has been contrived, besides its valuable scientific results, it will be productive of great benefit to the proprietors of steam ships, by supplying to them a never-failing check on every one concerned in the management of the vessel. Thus any relaxation of attention, or want of skill, on the part of those in care of the fires, will be indicated by the third pencil. Any neglect in feeding or blowing out the boilers will be indicated by the fifth and sixth pencils. The attention to the state of the condensing apparatus will be shown by the first pencil.

In the event of the temporary suspension of the operation of the machinery for adjustment, or any other cause, the fact of such suspension, its duration, and the time it took place, will be also recorded.

By the connexion of all the indicators with the time-piece, the exact hour, or indeed minute, of each registered circumstance will be recorded.—*Monthly Cron.* Lond. Mech. Mag.

Astronomical and Mathematical Instruments.

The Rev. Dr. Robinson, the celebrated astronomer of Armagh; who left England in September last, to visit the principal observatories of Bavaria, Italy, and France, and also to inform himself of the actual state of the art of astronomical instrument-making in those countries, has arrived in London. The observatories he visited on his route, were those of Manheim, Munich, Milan, Turin, Modena, Florence, and Paris. The workshops he saw in detail, were those of Ertel and Son, of Munich, and Gambey of Paris. The mechanical intelligence of the proprietors of these establishments, before which those of our English instrument makers dwindle into insignificance—the unreserved manner in which they severally communicated the various processes of the art they so pre-eminently cultivate, and the extraordinary beauty and accuracy of their work when finished, have excited in him (than whom no individual is better able to appreciate their value) the greatest admiration. As to the latter—namely, the exquisite workmanship of their instruments, the doctor states that British astronomers will soon have an opportunity of judging for themselves, as two of the meridian circles of Ertel and Son, are in progress; the one for the observatory of Mr. Cooper, M. P., for the county of Sligo; the other for the observatory at Glasgow. The circles of these instruments will be of three feet diameter, divided to two minutes, and, by achromatic micrometer microscopes, magnifying thirty times, these two minutes are subdivided so that an error in reading, amounting to a quarter of a second, can scarcely be committed. Mr. Cooper's instrument will have eight microscopes, and a telescope of nine and a half feet focus, and seven and a half inches aperture. This instrument, ordered only whilst Doctor Robinson was at Munich, will be erected immediately after the meeting of the British Association at Newcastle, in August next, at which Mr. Ertel, as well as Mr. Gambey, will be present. The Glasgow instrument is of the ordinary construction, such as are to be found, made by the same artists, in the observatories of Altona, Konisberg, Dorpat, St. Petersburgh, &c.; four microscopes, however, being substituted in lieu of verniers. The doctor also speaks in the highest terms of the workshops of Mr. Gambey, whose beautiful dividing can alone be compared to that of the Munich artists. Mln. Journ.

Lightning Conductors for Ships.

Mr. Editor,—I have read with much interest the scientific papers of your learned correspondent, W. S. Harris, Esq. F. R. S., upon the imperfect construction of the lightning conductors at present in use on board ships, and his comments upon a more perfect application of the results of science, as a defence against danger, which were elucidated in your last number by a diagram.

You will perhaps allow me to suggest, that a perfectly connected conductor may be obtained, according to the laws of electricity ex-

pounded by Mr. Harris, by the employment of copper wire, laid up after the manner of the wire rope lately introduced.

To fit a conductor in this way, it would be simply necessary to make one end fast at the masthead, and lead the other down into the water, by an out-rigger clear of the side. I conceive that the advantages of this plan, over that already proposed, are these: its simplicity of construction; its facility of being shifted when a spar is carried away, or when it is necessary to send a mast down; and that it can also be easily coiled up, and stored in a small compass, when out of use.

I believe the power of a conductor is measured by its extent of surface; and if this be correct, the rope of many wires would have a greater metallic surface than a bar of the same size, be at least as effective for the purpose as the connected lamina proposed by Mr. Harris, to whose consideration I have the pleasure, as a practical seaman, of offering my suggestions.

I am, Sir, &c.

E. Routh, H.C.S.

Jerusalem Coffee House, Nov. 4th, 1827.

Naut. Mag.

Anti Dry-rot.

The following letter has been addressed to the secretary of the Anti Dry-Rot Company, by Mr. Samuel Beazley, the architect.

"Sir:—At the commencement of the year 1836, I surveyed and accurately examined the posts and paling in the Regent's-park, for the purpose of ascertaining the comparative states of those timbers which had been prepared by Kyan's patent, and those which had not been submitted to the process of solution. In my report of that period, I stated that indications of decay were already perceptible in most of the unprepared timbers, both at the bottom of the posts, and in those arris edges and ends of paling which were placed, or had come at all, in contact with the earth, while those timbers which were marked as having passed through the solution, were quite free from any such symptoms. I now beg leave to state, that I have this day, after a lapse of two years and a quarter from my previous survey, again accurately examined several of the same posts and paling, digging away the earth from the foundations for that purpose, and find that the symptoms of decay mentioned in my preceding report as having commenced in the unprepared timber, have so considerably increased, as to have rendered the bottoms of the posts completely rotten, to a depth of from one to two inches, and that, in several instances, fungi have been the consequences of the decay; while I find the prepared timbers which are in the earth sound and in the same state, with the exception of mere discolouration upon the surface, probably arising from the damp state of the earth at the time of its removal. As a farther proof of the difference existing between the unprepared and the prepared timber, we could cut with the greatest ease large pieces from the former with the spade, without using any force, while it required great exertion to chip off very small pieces from the latter."

Min. Journ.

Improvement in Window Sashes.

Mr. R. B. Cooper, inventor of the patent spherical stoppers for bottles, jars, &c., the styloxynon, and several other useful articles, has just devised a most ingenious method of superseding the counterpoises and sash lines for windows. The principle will be invaluable in one of its proposed applications, viz: to the windows of stage coaches, omnibusses and railway-carriages; for as there is no *shake*, the present disagreeable and eternal rattle of the windows will be for ever silenced, and conversation rendered audible within the carriages, while carried on in the ordinary tone of voice. As it is probable that a patent will be secured for this simple and effectual contrivance, it would be unfair to enter into any further particulars at this time; suffice it to say, the proposed method is not only superior to, but also actually cheaper than, the old fashioned method of fitting and hanging windows.

W. B.

London, March 12, 1838. Lond. Mech. Mag.

Progress of Physical Science.

Security of Electric Jars from fracture by discharge.

The very frequent destruction of electric jars by perforation, splintering, or fracture, on being discharged at a high intensity, is a source of great annoyance and discouragement to the practical electrician. It is seldom, perhaps, that a battery is discharged after high excitement, without the fracture of one at least of its component jars. An investigation of the cause of this common occurrence has been made by W. Sturgeon, editor of the Annals of Electricity, whose experience in this department of Physics is probably as extensive as that of any person living. Jars are frequently broken by the injudicious practice of placing one knob of the discharger against the side of the jar, while the other knob is made to approach the ball at the top of the jar. It is better to place the jar, when charged, on any good conducting substance, such as a piece of tin foil, or metallic sheet of any kind, and in discharging, to connect this sheet with the ball of the jar.

The fracture, or star, almost always occurs near the top of the lining. From this it was inferred that "the fluid strikes the wire from the upper parts of the lining in almost every discharge from high intensity; and that those jars which are not broken owe their safety to the strength of the glass."

The remedy prescribed, and the results, I give in the author's own words. G.

The electric fluid in the interior of an intensely charged jar indicates the greatest tendency to escape from the top of the lining; and that by the present mode of fitting up jars, an explosion from that part of the lining to the wire probably takes place whenever the jar is discharged through good conducting media, it seemed the most natural method, to *lead* the fluid, as it were, by some good conducting substance by the nearest route, and dispense altogether with the wire and chain that are suspended in the axis of the jar. For this purpose, two slips of tin-foil were secured to the opposite sides of the jar, and reached from the upper edge of the *lining* to the cover on the top; the under part of which was also covered with foil. This latter portion of the foil communicated with the lower extremity of the wire which supports the ball: so that a complete and direct metallic connexion

now existed between the top of the lining and the ball on the top of the jar. Therefore, no explosion in the interior of the jar could possibly take place. The result was, that every jar so fitted up has hitherto withstood the most severe trial. I have, for the last twelve years, employed jars thus protected, without ever breaking one by a discharge: although, during that period, I have discharged a battery of twelve jars some hundreds of times from the most intense electrization. I have called the slips of foil *protectors*: and I am firmly persuaded, that the most extensive battery may, by this means, be perfectly protected.

The next question that naturally presents itself, is, does the insulation continue as perfect in jars thus protected, as in those fitted up in the usual way?

Upon attentive examination, it will be found that the ball and wire of the ordinary jar, must always be electrized equally with the lining with which they are connected by means of the chain; and therefore the insulation from the lining to the coating, in such jars, can only be from the centre of the cover through which the wire passes to the upper edge of the coating: and as the cover is of wood, which is always a partial conductor, it also becomes charged in common with the wire and lining. Therefore, the only perfect insulation is that between the edge of the cover and top of the coating—exactly the same as in jars furnished with protectors.

When jars are cylindrical throughout, no covers need be used. A disk of wood of nearly the same diameter as the interior of the jar, is fixed by wedges of cork at the same height as the top of the lining. This disk is covered with tin foil, and the lower end of the wire carrying the ball is screwed into its centre. In addition to the cork wedges, I usually support the disk by three wooden rods, which rest on the bottom of the jar.

It is not my intention, however, to press the theoretical part of this paper too strongly on the attention of the society; because I am well aware that, unless experiments were made to show that the fluid actually leaps from the upper edge of the lining to the axial wire of ordinarily fitted up jars, it might lead to unnecessary doubts in the minds of those who have paid but little attention to the pursuit of a cause whose effects are the most disheartening that the amateur electrician has to contend with.

I have pointed out what has appeared to me to be the cause of these accidents to jars; and have briefly described the mode of investigation, both mental and experimental, which I pursued: and, whether my theoretical views be considered satisfactory or otherwise, the simple fact, alone, of my not having broken even one jar, thus fitted up, although I have constantly employed them for the last twelve, or more, years, during which, but few have had more extensive practice, may, perhaps, be sufficiently important to induce other electricians to adopt the same mode of protecting *their* jars which, for so long a course of practice, has afforded a complete protection to mine. If I have succeeded in this particular, the principal object for offering this paper to the notice of the Electrical Society will then be accomplished.

Annals of Electricity.

Concomitance of Chemical, and Vital, with Electrical Action.

M. Becquerel has described a most simple apparatus for the development of electricity, consisting merely of a syphon filled with fine sand, and having one leg filled with an acid, the other with an alkaline solution. These fluids meet at the most depending part of the tube, where there is an orifice plugged by a bit of asbestos, which conveys away the compound solution as fast as formed. Wires placed in the two legs

indicate strongly opposed electrical states, and the voltaic current thus produced, continues until all the fluid elements have been united. It is impossible to consider this result without acknowledging the remarkable influence which *capillarity* must have over chemical action, a condition so evident and constant in organized beings.

The late researches of Dr. Faraday have fully proved the identity of electrical with chemical affinity, and that all chemical changes are attended with a disturbance of electric equilibrium. If therefore the changes occasioned by the growth of organized systems are immediately governed by laws similar to those of inorganic matter, we should expect to find that electricity is constantly being developed by them, in the same manner as we, artificially, obtain it by chemical decomposition, or recomposition.

There is no deficiency of evidence that this is the case. During the germination of seeds, the two principal changes are the rejection of carbonic and acetic acids; and it has been recently ascertained that there is at the same time a manifestation of electric action. The seed may indeed be considered an electro-negative system, retaining the bases and rejecting the acids; and it has been accordingly found that grains applied to the negative extremity of a voltaic pile, germinate much more rapidly than those uninfluenced; and that positive electrical influence retards the process. In like manner, slightly alkaline solutions accelerate, and acids delay or altogether check it. In the later periods of vegetable growth, the contemporaneous chemical changes are by no means uniform in character; and it is probably from this cause that artificial currents of electricity do not seem to assist the growth of plants, although atmospheric electricity, which is undoubtedly much connected with the processes of vegetation, appears to accelerate it. That there is constant electric disturbance during the growth of plants, has been fully proved by the experiments of Pouillet; and by many writers, the changes produced by the exhalation of fluid, and the gaseous alterations effected by the leaves, are believed to be the main sources of the constant variations in the electric state of the atmosphere.

The connexion of *capillarity* with electric action has been already noticed; but some other facts may be briefly stated. Various substances having minute, porous structure, possess the power of occasioning the union of oxygen and hydrogen at comparatively low degrees of heat; thus spongy platinum will produce this effect at common temperatures, and charcoal, or porcelain biscuit, at about 300°. It does not seem very clear to what this power is to be attributed; and we are almost equally in the dark regarding the phenomena of endosmose, in which electricity would appear to have some share, the known laws of capillary action not being adequate to explain some of the recently observed facts.*

Many facts corresponding with those to which we just now alluded as having been obtained with regard to the electrical state of different organs of animals, have been remarked in vegetables also. Thus it has been ascertained that wires passed into the pith, and applied to the bark, indicated opposite electrical states; and the same is true of the two extremities of most fruits. Some of the most interesting proofs of the occurrence of electric actions in plants are derived from the experiments of M. Becquerel and Mr. Crosse, on the effect of currents of voltaic electricity of very feeble intensity, in producing the crystallization of

* Cyclopedia of Anatomy, p. 110.

many substances, which, from their insolubility, the chemist has been hitherto unable to procure in that form, but which occur abundantly in vegetables, such as silex, and the carbonate and oxalate of lime. Now, unless we suppose that vital affinity, or action, possesses this remarkable property in common with electricity, a supposition which appears entirely gratuitous, we cannot hesitate to set down the deposit of these salts in a crystalline state in the vegetable tissues, to the electricity developed by other chemical actions going on in the plant.—*W. B. Carpenter.*

Ed. New Phil. Journ.

Stratification of Minerals by Voltaic Electricity.

The following experiments are stated by William Norris, in Sturgeon's Annals of Electricity, to have been performed by Mr. John Leathart of Alston, Cumberland. They are in confirmation of those described by Robert Were Fox, Esq.*

Portions of different rocks were reduced to a fine powder and mingled together with water into a homogeneous mass, of the consistence of soft clay, or mud. After being subjected to the action of a current of electricity from ten days to a fortnight, these compounds were separated into distinct layers or strata of the different rocks which had been mixed together; the line of division between the strata being at right angles to the direction of the current.

A variety of interesting phenomena were observed in the course of these experiments. In one case blue limestone was separated from an equal quantity of argillaceous matter, with which it had been mixed, and was converted into white marble. In another experiment, portions of carboniferous (blue limestone,) siliceous (brown freestone,) and argillaceous (plate or shale) rocks were mixed together. The limestone was collected at the positive, or zinc, end, the plate at the negative, and in the centre the freestone formed a stratum having the appearance of white quartz. Ibid.

Effects of the Lightning on the Melville Monument, struck on the 14th of July, 1837.

The following particulars are curious:—The door which leads to the outer plinth at the top of the monument, immediately below the statue, fell to the bottom the instant the monument was struck; but, upon being inspected about three-quarters of an hour afterwards, there did not appear any of the usual effects of the electric fluid upon the ironwork or otherwise. The key of the door below, which leads to the top of the monument, was obtained, and upon entering it no appearance of damage could be discovered. On reaching the top of the stair, however, it was found that the stones which form the apex of the central part of the monument, upon which the stair rests, and which are perforated from the cupola to the bottom, on purpose to admit the conductor, were dislodged. The conductor was a chain, part of which was discovered still hanging at the top of the cupola, immediately underneath the statue. The rest of the chain was not to be seen, but upon descending to the bottom, and looking underneath the centre, upon which the stair is fixed, the chain was found in a heap, quite hot, and having a white calcined appearance. It would appear, therefore, that the door had

* Journal Franklin Institute, page 251, Vol. XXI.

not been struck by the lightning, but had been forced out by the concussion, arising from the aperture, which leads down through the centre of the stair from the top of the monument, being too small to admit the shock; which circumstance, causing a momentary interruption, had had the effect of dislodging the stones at that place for a couple of yards, wresting the door from the hinges, and breaking the chain. From all these circumstances it would appear that the conductor saved the monument.—(*Caledonian Mercury.*)

Archi. Mag.

Mechanics' Register.

Astonishing facts relative to a former Organic World.

"Dr. Buckland now proceeds to the most important and popular branch of his subject—to give a description of the most interesting fossil organic remains, and to show that the extinct species of plants and animals which formerly occupied our planet, display, even in their fragments and relics, the same marks of wisdom and design which have been universally recognized in the existing species of organized beings.

"After giving some account of the supposed cases of fossil human bones, and establishing the remarkable fact of the 'total absence of any vestiges of the human species throughout the entire series of geological formations," our author passes to the general history of fossil organic remains:—

"'It is marvellous that mankind should have gone on for so many centuries in ignorance of the fact, which is now so fully demonstrated, that no small part of the present surface of the earth is derived from the remains of animals that constituted the population of ancient seas. Many extensive plains and massive mountains, form, as it were, the great charnel-houses of preceding generations, in which the petrified exuviæ of extinct races of animals and vegetables are piled into stupendous monuments of the operations of life and death, during almost immeasurable periods of past time. "At the sight of a spectacle," says Cuvier, "so imposing, so terrible as that of the wreck of animal life, forming almost the entire soil on which we tread, it is difficult to restrain the imagination from hazarding some conjectures as to the cause by which such great effects have been produced." The deeper we descend into the strata of the earth, the higher do we ascend into the archæological history of past ages of creation. We find successive stages marked by varying forms of animal and vegetable life, and these generally differ more and more widely from existing species as we go further downwards into the receptacles of the wreck of more ancient creations. * * * *

'Besides the more obvious remains of testacea and of larger animals, minute examination discloses, occasionally, prodigious accumulations of microscopic shells that surprise us no less by their abundance than their extreme minuteness; the mode in which they are sometimes crowded together may be estimated from the fact that Soldani collected from less than an ounce and a half of stone, found in the hills of Casciana, in Tuscany, 10,454 microscopic chambered shells. * * * Of several species of these shells, four or five hundred weigh but a single grain; of one species he calculates that a thousand individuals would scarcely weigh one grain.'

"Extraordinary as these phenomena must appear, the recent discoveries of Ehrenberg, made since the publication of Dr. Buckland's work, are still more marvellous and instructive. This eminent naturalist, whose discoveries respecting the existing infusorial animals we have already noticed, has dis-

covered fossil *animalcules*, or infusorial organic remains; and not only has he discovered their existence by the microscope, but he has found that they form extensive strata of tripoli, or poleschiefer (polishing slate,) at Franzenbad, in Bohemia—a substance supposed to have been formed from sediments of fine volcanic ashes in quiet waters. These animals belong to the genus Bacillaria, and inhabit siliceous shells, the accumulation of which form the strata of polishing slate. The size of a single individual of these animalcules is about 1.288th of a line, or the 3400th part of an inch. In the polishing slate from Bilin, in which there seems no extraneous matter, and no vacuities, a cubic line contains, in round numbers, 23,000,000 of these animals, and a cubic inch 41,000,000,000 of them. The weight of a cubic inch of the tripoli which contains them is 270 grains. Hence there are 187,000,000 of these animalcules in a single grain; or the silicious coat of one of these animals is the 18,000,000th part of a grain!

"Since this strange discovery was made, Mr. Ehrenberg has detected the same fossil animals in the semiopal, which is found along with the polishing slate in the tertiary strata of Bilin, in the chalk flints, and even in the semiopal or noble opal of the porphyritic rocks. What a singular application does this fact exhibit of the remains of the ancient world! While our habitations are sometimes built of the solid aggregate of millions of microscopic shells—while, as we have seen, our apartments are heated and lighted with the wreck of mighty forests that covered the primeval valleys—the chaplet of beauty shines with the very sepulchres in which millions of animals are entombed! Thus has death become the handmaid and the ornament of life. Would that it were also its instructor and guide!"—*Ed. Review.*

Min. Jour.

LUNAR OCCULTATIONS FOR PHILADELPHIA, SEPTEMBER 1838.

Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. For direct vision add 180°

Day.	H'r.	Min.	Star's name.	Mag.	from Moon's North point.	from Moon's Vertex.
1	13	54	Im. χ Capricorni	5,6	149	189
1	14	47	Em.		271	317
5	12	0	Im. (189) Piscium	,6,	169	139
5	12	53	Em.		270	254
8	12	20	Im. 9 Tauri	,6,	161	104
8	13	6	Em.		256	200
8	16	51	Im. *b* Pleiadum	,5,6,	155	175
8	17	52	Em.		251	295
8	17	22	Im. *d* Pleiadum	,5,	91	125
8	18	38	Em.		303	359
8	18	5	Im. *e* Tauri	,3,	104	148
8	19	23	Em.		291	347
11	12	6	Im. *c* Aurigae	,6,	112	64
11	12	59	Em.		261	208
11	14	7	Im 54 Aurigae	,6,	153	95
11	14	44	Em.		221	162
18	3	12	25.4s Begin.* Solar Eclipse		235	278
18	4	30	18.7s Begin. Ring			
18	4	32	44.7s nearest approach of Centres			
18	4	35	10.7 end of Ring			
18	5	44	38.0 end of Solar Eclipse		56	107

*See August Number for 1837 of this Journal.

House Painting.

A very simple method has lately been adopted to render the surface of paint perfectly smooth, and eradicate the brush marks. It is done by a small roller covered with a cloth, or felt, eight inches long and two inches in diameter, worked in an iron frame on pivots, similar to the common garden roller. The flatting coat by this method is made beautifully even, and looks exceedingly well. (*Athenæum*, Nov. 4, 1837.) Archit. Mag.

Harefield Copper and Zinc Works.

The great novelty in these works seems to be the fine process of manufacturing sheet zinc, which the company have been the first to bring to perfection in this country. The use of plates of malleable zinc is now becoming very general; and seems, indeed, to be universally introduced in the modern system of building. It is fast taking the place of copper in many instances, and of lead and tin in many more, being so much cheaper and lighter than the two former. Thus, copper is about 102*l.* per ton: sheet zinc about 25*l.* per ton. Lead is the same price as the zinc, but requires to be four times thicker when laid down, which, of course, makes it three-fourths dearer.—*Monthly Repository.* Ibid.

Meteorological Observations for March, 1838.

Moon.	Days.	Therm. Sun rise.	Therm. 2 P.M.	Barometer. Sun rise.	Barometer. 2 P.M.	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inch's	Inch's			Inches.	
	1	16	32	30.96	30.00	W.	Moderate.		Clear—do.
	2	21	35	29.85	29.96	NE.	do.		Partially cloudy—do. do.
☾	3	20	34	30.15	30.20	N.	do.		Partially cloudy—cloudy.
	4	23	39	29.76	20	NW.	do.		Clear—do.
	5	32	36	85	29.45	E.SE.	do.	.90	Snow—rain
	6	36	49	65	76	W.	do.		Clear—do.
	7	34	38	80	80	E.	do.		Snow—drizzle.
	8	33	36	70	65	E.	do	.55	Drizzle—rain.
	9	33	49	90	90	W.	do.		Cloudy—do.
	10	35	48	30.15	30.15	W.	do.		Clear—do.
☉	11	33	48	00	29.87	W.	do.		Clear—lightly cloudy.
	12	37	33	29.80	90	W.	do		Clear—flying clouds.
	13	32	54	30.05	30.10	W.S.	do.		Clear—do.
	14	32	54	00	00	NW.	do.		Clear—cloudy.
	15	40	58	29.85	29.80	W.	do.		Cloudy—clear.
	16	42	56	80	80	N.	Blustering.		Cloudy—cloudy.
	17	36	43	78	75	E.	do	1.25	Rain—rain and snow.
	18	32	34	55	56	NE.	do	.05	Snow—do.
☽	19	32	42	55	55	W.	Moderate.		Clear—do.
	20	37	56	56	50	W.	do		Clear—do.
	21	38	54	70	90	NW.NE.	do.		Cloudy—lightly do.
	22	36	43	30.10	30.10	E.	do.		Cloudy—do.
	23	39	46	20	15	W.SW.	do.		Cloudy—do.
	24	37	67	29.93	29.90	SW.	do.		Cloudy—lightly do.
⊗	25	38	50	30.20	30.24	W.N.	do.		Cloudy—clear.
	26	38	68	05	05	W.	do.		Clear—clear.
	27	39	48	0	29.85	E.	do	.05	Lightly cloudy—shower.
	28	32	42	00	30.05	E.	do.		Cloudy—do.
	29	36	48	29.45	29.40	W.	Blustering	.09	Rain—flying clouds.
	30	36	56	50	50	W.	Moderate.		Clear—do.
	31	40	57	60	60	SW.	do.		Cloudy—clear.
	Mean	33.71	47.51	29.86	29.8[illegible]			2.87	

	Thermometer.	Barometer.
Maximum height during the month.	68.00 on 26th.	30.75 on 23rd,
Minimum do.	16.00 on 1st.	29.40 on 29th.
Mean do.	40.61	29.87